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THE SCOPE AND IMPORTANCE TO THE STATE OF THE SCIENCE OF NATIONAL EUGENICS[1]

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IT needs more than a little boldness to suggest within the walls of one of our ancient universities that there is still another new science which calls for support and sympathy; nay, which in the near future will demand its endowments, its special laboratory, its technical library, its enthusiastic investigators and its proper share in the curriculum of academic studies.

The prestige of an ancient university does not wholly depend on the extent and novelty of the fields it cultivates, nor even on the external reputation of its doctors and masters. I remember my Savigny well enough to know that historically a university does not express the universality of the learning taught within its walls, but that the word emphasizes the corporate character of its masters and scholars. I also understand—with the experience of four universities behind me—not only the social, but the educational value of the traditional *universitas* of the middle ages; that common life of teacher and scholar which we now find preserved in broad outline, if in detail obscured, at two English universities alone.

As your guest to-day, even if I had the necessary knowledge, it would be ill-fitting to praise or to criticize modern Oxford. My intellectual debt to Oxford is too great to make me an unbiased judge; looking back on the stadia of intellectual growth from the days of the Oxford schoolmaster who taught me scientific method and a love of folk-lore in failing to teach me Greek grammar, the sign-posts are marked with Oxford names, whose moment to me must be a small part of what it formed to the mental life here. I note those: of Mark

[1] Fourteenth Robert Boyle lecture delivered before the Oxford University Junior Scientific Club on May 17, 1907.

Pattison, from whom I learned that the method of science is one with the method of true scholarship; of Henry Nettleship, whose width of view in academic matters aided those of us who were struggling against prerogative and prejudice in London; of York Powell, who taught me that a study of history is incomplete if it pass by the great biological factors which make for the rise and fall of nations; of Raphael Weldon, whose life culminated in Oxford, and whose activity will, I trust, continue to bear fruit here—of Weldon who taught us that biology is ripe for receiving aid from the exact sciences; who, breaking down yet another barrier, emphasized the unity of logical method throughout the whole field of knowledge.

The calm, critical judgment of these men, their scorn, one and all, for the rhetorical, the superficial, the *idola* of the market-place, have built up my Gentile conception of Oxford and given me a not unwholesome fear of an Oxford audience. Their keen power of sympathy, however, their very intense, if much repressed, national spirit—amounting to the truest form of patriotism—would, I believe and trust, have been not wholly withdrawn from me to-day in my endeavor to put before you the claims of this new science of mankind.

I do not demand your attention for this new field of inquiry because a university is expected to embrace all sciences. On the contrary, I do it partly because I think the success of a university, as of an individual, depends largely on specialization in study. Now there is one form of technical education, which, although Oxford is too modest to give it a name, has yet been largely claimed for this university. I refer to the education of statesmen and administrators. There is need, I venture to hold, of a more conscious recognition of the existence of a school of statecraft, and that recognition must involve a fuller study of what can make and what can mar national life and racial character. We are told by a poet, who, understanding the spirit of his age, carefully balanced himself on the fence which separates the field of true insight from that of conterminous platitude, that "the proper study of mankind is man." But he has not helped us to see wherein this proper study of man consists. In all our universities there are branches of study which deal more or less directly with man. We have philosophy with its discussions of man's mental processes, ethics with the consideration of man's affections, passions and conduct; Fichte, Hegel and other ethical philosophers have given us, here and there, luminous ideas, flash-lights on society and state. But has philosophy, as such, taught us a single law by aid of which we can understand how a nation becomes physically or mentally more vigorous? Has it taught our statesmen to make their folk fitter for its task on the world-stage, or helped a race to meet a crisis in its history? We have had other branches of the science of man, measuring him, classifying him by his hair, by his skin or by his skull. Yet anthropometry and craniometry,

while piling up facts and figures, have done little to enable us to see wherein human fitness for its functions really consists. Their professors disagree, much as do those of another branch of the study of man—political economy. What weight have philosophy, anthropology or political economy at present in the field of statesmanship? Would the man who, rising in the House of Commons to-day, appealed to the laws of economic science, be even sure of a hearing? And if we turn to the study of history, surely more potent than these other branches in the aid it provides for the administrator, is not its lesson rather that of example and analogy than of true explanation and measurement of the causes of national evolution?

If the German people dominates to-day the French; if Japan rises like a mushroom—with the stability and the strength of the oak; if Spain and Holland disappear from the fore rank of nations, can we throw light even for an instant on these momentous facts of history by such studies of mankind as are summed up in philosophy, anthropology or political economy? I fear not. As instruments of education, as means of illustrating logical method, or of developing powers of healthy inquisitiveness and effective expression, they may be of value, in part indeed of unrivaled value. But as they stand at present they do not, alone or combined, form a technical education in statecraft.

And here I would like to make a fundamental distinction between what I understand by a technical education and a professional instruction. I do not believe that the university ought to busy itself in the least with the latter. It is taught most effectively in the barrister's chambers, in the architect's office, in the engineering workshop, in the government department, or in the hospital ward. The tendency nowadays to replace apprenticeship by professional instruction in college or university is a fatal one. The academic purpose should be concentrated on the development of the mind as an instrument of thought. It may do this by aid of philosophy, or by aid of language, or of science; but it can not do it by any form of purely professional instruction. By technical education I mean something very different from an instruction in the facts, formulæ and usages of a profession. It consists, I hold, not in learning an art, but in developing the mind by studying that branch of science which must lie at the basis of each profession. The theory of elasticity is as potent an instrument for mental discipline if we illustrate it on bridge-structure, as if we confined our attention to metal spelks and snips of pianoforte wire in the physical laboratory. The science of medicine—think for a moment even of such points as immunity, incubation and crisis—affords material for reasoned observation and leads to a mental alertness, which may be equaled but can not be excelled in any other branch of biological inquiry. The true test of all technical education lies in whether we can answer in the affirmative the question: Does it provide adequate mental training for the

man who has no intention of professional pursuits? If we can, then, and then only, may we assert that it is a fit subject for academic study.

By a superficial knowledge of many things, we break all continuity in education; we may reach a "top-dressing," but the subsoil has never been turned and cultivated. From this standpoint, academic education will, I feel certain, grow more and more technical education; the man who has exercised his mind in thoroughly examining one small field of knowledge, who has seen its solved and unsolved problems, and who has tried his own powers in even some little bit of pioneer work, has received a training which will stand him in good stead, whatever he may afterwards turn his mind to in life. I can conceive a great university for the training of mind, in which the whole teaching force should be devoted to the manufacture of problems, calculated to exercise and develop the youthful mind, without any regard to their bearing on real knowledge. Such was very nearly the system of the Cambridge mathematical school of a generation ago. It produced splendid lawyers, subtle theologians and a few ardent students of science. But the labor expended in the manufacture of problems, the sole purpose of which was to provide material for mental gymnastics, might have achieved European reputation for the manufacturers had it been devoted to the pressing problems of technical science. It is because every university has a duty in the creation of new knowledge, as well as a duty in education, that it seems desirable that our mental training should take as its problems those which are actually demanding solution in practical life.

If we are to have a school of statecraft, I venture to suggest that a special technical education shall be developed for it. We must not be content with the mental gymnastics which can be provided by philosophy or political history. We must add that study of the biological factors which York Powell saw was so needful to historical investigation. We must approach with the detached mind and calm criticism of Mark Pattison those problems as to the rate of change of races, a knowledge of which Raphael Weldon has told us is "the only legitimate basis for speculations as to their past history and future fate."

If we attempt to define the scope of statecraft we enter no doubt the field of controversy, but may we not extend the condition which so fitly expresses the primary need of the individual—the healthy mind in healthy body—to the swarm of individuals with which the statesman has to deal? Taking the word "sanity" in its broadest sense of health and soundness, the primary purpose of statecraft is to insure that the nation as a whole shall possess sanity; it must be sound in body and sound in mind. This is the bedrock on which alone a great nation can be built up; by aid of this sanity alone an empire once founded can be preserved. There are secondary important conditions—too often regarded as primary—which are undoubted parts of statecraft. The nation must have the instruments and the training needful to protect

itself and its enterprises; it must hold the sources of raw material and the trade routes requisite to develop the wealth upon which its population depends; it must have the education necessary to make its craftsmen, its traders, its inventors, its men of science, its diplomatists and its statesmen the equals at least of those of its rivals on the world-stage. Nay, perhaps as important as all these, it must have traditions and ideals so strong that the prejudices of individuals and the prerogatives of classes will fall before urgent national needs; it requires teachers, be they pressmen, poets or politicians, who grasp the wants of the nation as a whole; who, independent of class and party, can remind the people at the fitting moment of their traditions and their special function amid nations.

Yet if we come to analyze these secondary conditions, we shall find in each case that their realization depends on the fulfilment of our primary condition. Without high average soundness of body and soundness of mind, a nation can neither be built up nor an empire preserved. Permanence and dominance in the world passes to and from nations even with their rise and fall in mental and bodily fitness. No success will attend our attempts to understand past history, to cast light on present racial changes, or to predict future development, if we leave out of account the biological factors. Statistics as to the prevalence of disease in the army of a defeated nation may tell us more than any dissertation on the genius of the commanders and the cleverness of the statesmen of its victorious foe. Lost provinces and a generation of hectoring may follow to the conquered nation whose leaders have forgotten the primary essential of national soundness in body and mind.

Francis Galton, in establishing a laboratory for the study of national eugenics in the University of London, has defined this new science as "the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally." The word *eugenic* here has the double sense of the English *well-bred,* goodness of nature and goodness of nurture. Our science does not propose to confine its attention to problems of inheritance only, but to deal also with problems of environment and of nurture. It may be said that much social labor has already been spent on investigating the condition of the people; there have been royal commissions, parliamentary and departmental committees, and much independent effort on the part of philanthropists, medical men and social reformers. I would admit all this, and would try to appraise it at its true value. Some of it has provided useful material for eugenic study; much of it is the product of wholly irresponsible witnesses with comments by commissioners equally untrained in dealing with statistical problems. Witnesses, commissioners, philanthropists, social reformers, as a rule, and medical men only too frequently sadly need that technical education, that power of reasoning about statistical

data, which I think will become general when eugenics has been made a subject of academic study, and minds specially trained to this branch of scientific inquiry are placed at the disposal of our statesmen. I do not, of course, say that there was no eugenic research before Francis Galton invented the word and named the new science. But I believe the day not distant when we shall recognize that he seized the psychological moment to assert its claim to academic consideration; and that in the time to come the nation will be more than grateful to the man who said that the university is the true field for the study of those agencies which may improve or impair our racial qualities. To become a true science, you must remove our study from the strife of parties, from the conflict of creeds, from false notions of charity, or the unbalanced impulses of sentiment. You must treat it with the observational caution and critical spirit that you give to other branches of biology. And when you have discovered its principles and deduced its laws, then, and then only, you can question how far they are consonant with current moral ideas or with prevailing human sentiment. I myself look forward to a future when a wholly new view as to patriotism will be accepted; when the individual will recognize more fully and more clearly the conflict between individual interests and national duties. I foresee a time when the welfare of the nation will form a more conspicuous factor in conduct; when conscious race-culture will cope with the ills which arise when we suspend the full purifying force of natural selection; and when charity will not be haphazard—the request for it being either a social right, or the granting of it an anti-social wrong. But if we are to build up a strong nation, sound in mind and body, we shall have to work in the future with trained insight: I feel convinced that real enlightenment will only follow a scientific treatment of the biological factors in race development.

There is an element of danger in the study of eugenics, which I would not have you overlook. If the attention be fixed on the factors which make for deterioration; if we spend our days over statistics of the insane, the mentally defective, the criminal, the tuberculous, the blind, the deaf and the diseased, the inevitableness of it all is apt to reduce us to the lowest depths of depression. But this is only one side of the picture; the inevitableness is just as marked when we come to deal with health and strength, with ability and intelligence. If the iniquity of the fathers be visited upon the children to the third and fourth generation—assuredly so is their virtue. If this needs emphasis, study the two pedigrees I put before you. In Fig. 1 we have the pedigree of a family in which eccentricity, insanity and phthisis have recurred generation by generation—associated occasionally with great ability. The general "want of mental balance" is the mark of the stock. In Fig. 2 we have the pedigree of a family in which extreme

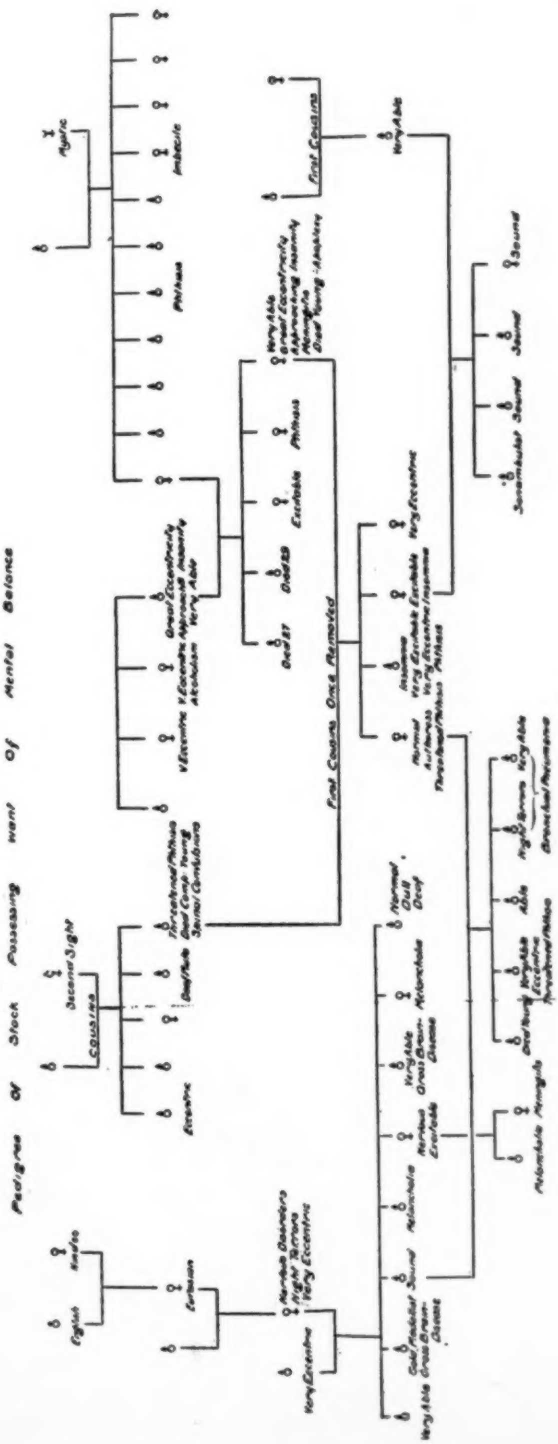

Pedigree of Stock Possessing want of Mental Balance
Cousins
First Cousins Once Removed
First Cousins

FIG. 1.

ability not correlated with such want of mental balance has descended through five generations.

Yet apart from this, to the true man of science, nothing is impure or repulsive. His mission is to study all phases of life; and in the case before us to determine their relation to national fitness and racial degeneracy. I can not put it better than in the words of Francis Bacon:

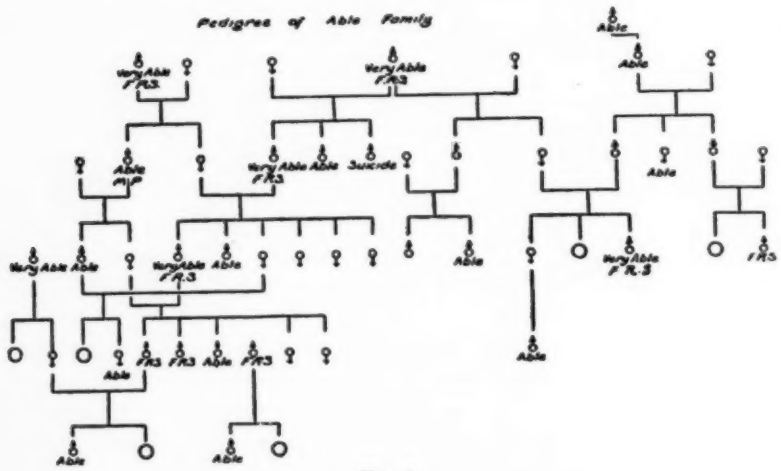


FIG. 2.

But for unpolite or even sordid particulars which, as Pliny observes, require an apology for being mentioned, even these ought to be received into natural history, no less than the most rich and delicate; for, natural history is not defiled by them any more than the sun, by shining alike on the palace and the privy; and we do not endeavor to build a capitol or erect a pyramid to the glory of mankind, but to found a temple in imitation of the world, and consecrate it to the human understanding, so that we must frame our model accordingly; for whatever is worthy of existence is worthy of our knowledge; but ignoble things exist as well as the noble.

Those who have not the courage, or it may be the strength to face life as it is, must avoid science; or at least the portion of it termed national eugenics. Those who fear to know humanity in its degradation, as well as in its nobler phases, will scarce reach the standpoint of knowledge from which they can effectively help the progress of our race. They will be ignorant of the essential factors which alone can determine whether a nation shall be sound in mind and body. Disease and health, vigor and impotence, intelligence and stupidity, sanity and insanity, conscientiousness and irresponsibility, clean living and license —all things which make for strength and weakness of character—must be studied, not by verbal argument, but be dissected under the statistical microscope, if we are to realize why nations rise and fall, if we are to know whether our own folk is progressing or regressing. Only by such examination can we understand the disease; only by such means can we suggest a valid cure where we find there is that in any com-

munity which is making for degeneracy. The study of eugenics centers round the actuarial treatment of human society in all its phases, healthy and morbid.

In every branch of science there exist, I believe, three chief stages of development. These stages are not always completely differentiated, and forms of the earlier stages may usefully survive into the later periods.

The first stage is the *ideological*. Men have formed ideas about phenomena on the basis of very limited experience. They spend their time and energy in discussing these ideas without much reference to the phenomena themselves. This discussion of ideas—this wrangling over definitions—is not idle. It not only led in medieval times to a philosophy which gave a by no means contemptible educational training; but in some of the most developed forms of science, as in the foundations of our most advanced pure mathematics, ideology can again do work of the greatest service. It corresponds to the pre-Baconian state of most sciences.

The second stage is the *observational*. It is a reaction against the purely introspective attempt at a natural philosophy. It consists in observing phenomena critically, and recording and describing their sequences. It is a fundamental stage towards any really scientific theory of nature. It will always remain a large factor in scientific work. But while it needs the mind of special width and creative power to invent a reasonable theory, and demonstrate it by the right type of observation, it is possible for the average man to observe carefully and to go on observing through a long lifetime. The result is the accumulation for decades and decades of observations made with little idea of testing a definite theory of organic or inorganic nature. These observations form a large proportion of scientific literature; and, I fear, are not always of service when the creative scientist desires to test his theories. The time spent in hunting up data, which may after all fail to give the special small detail requisite, would often have sufficed to produce more adequate observations made *ad hoc*. Hence I think there will be, if there be not already, a reaction against purely observational or descriptive science.

The third stage in all science is the *metrical*. We proceed from observation to measurement, to accurate numerical expression of the sequences involved. It has been more than once asserted that by quantitative analysis you can not obtain more than lies in the data from which you start. The statement is either merely platitude; or else, if more than idle, it is false. The object of analysis is *not* to obtain more from data than exists therein; but to find out what actually does exist therein; and that is usually far from obvious to untrained inspection. The actual positions of the moon can be observed and recorded day by day. Such are the data. Shall we assert that lunar theory as it

exists to-day—the product of nearly two and a half centuries of work by some of the finest mathematical intellects—contains no more than the data from which they started? I think we may leave such an attitude to those who do not grasp that the highest aim of science is not the presentation of facts, but the regulating of a world of conceptions, by aid of which we can mentally describe those facts. From the data themselves we have to determine whether this "statuting of mind" is legitimate within the limits of our observations. "Analysis can not get more out of the data than is already in them," cries the biologist. On the contrary, having added to the data *mind,* the combination provides a great deal that had no previous existence. Even Huxley could write:

> Mathematics may be compared to a mill of exquisite workmanship, which grinds your stuff to any degree of fineness, but nevertheless what you get out depends on what you put in; and as the grandest mill in the world will not extract wheat-flour from peascods, so pages of formulae will not get a definite result out of loose data.

On the contrary, I assert that our modern mathematical methods reach a perfectly definite result when applied to such data; they measure the deviation, the differentiation of pease-meal from wheat-flour; that is to say, they determine quantitatively the exact degree of looseness in the data themselves. Is it fear of discovering the exact degree of looseness in their own data, which leads some votaries of descriptive science to belittle metrical investigations?

Nay, I do not hesitate to assert that any branch of science, until it reaches its third or metrical stage of development, is incomplete and fails to provide the highest mental training possible. There are few departments of scientific investigation which provide so thoroughly for discipline in all the three branches of science, the ideological, the observational, and the metrical, as biology; this is particularly true of its applications to man. What better training in ideology than a study of the theory of the state from Plato, through Aristotle and Hobbes till we reach, in Comte, the view that the science of society is impossible without biology? What fitter training in observation than the biologist provides, when he teaches us experimentally the facts of inheritance and the influences of environment? What more precise exercise for the mind than the actuarial appreciation of these biological factors "as agencies which improve or impair the racial qualities of future generations"?

Here, I firmly believe, is in broad outline the scheme necessary to form a school of statecraft. The mind must be led through each of the ascending stages of science—till it is able to measure accurately and to describe in fitting words those fundamental biological factors on which the progression and the debasement of human societies alike depend.

But you may ask me if I am not painting a science of the future;

if I am not merely repeating the vague words of the old sociologists, from Comte to Herbert Spencer? Where is the material, what are the methods, how definite are the deductions of this new science of eugenics?

First then: where is the material?

I reply that every large school and university in this country can provide physical and psychical material for the student of eugenics if he will set to work and observe. Every medical officer in asylum and hospital is in charge of a great eugenics laboratory if he would only realize it. And many indeed are realizing it. Quite recently between 300 and 400 pedigrees of tuberculous stock; 400 family histories of insanity; 400 descriptions of parentage and home environment of mentally defective children, with as many of normal children from one district, and upwards of 1,000 from a second district, have reached the Eugenics Laboratory in London. If this seems to lay all stress on the abnormal and defective side, I may add that the laboratory possesses records of nearly 400 noteworthy families—a part of which have been published—and that I have reached now a series of nearly 300 normal family histories, many of them containing 50 to 100 individuals, with psychical and physical descriptions and entries as to ailments and causes of death. These are but, of course, the beginnings of a collection which one hopes and trusts will one day represent large samples of the physique, the mentality, the fertility and the disease of wide classes of the nation. The success of this sort of eugenics laboratory collection depends upon spreading widely three convictions: (1) that really useful results have flown, and will flow, from contributing to it; (2) that individuals, if appealed to frankly, will frankly tell the truth that lies within their knowledge; and (3) that the individual becomes a non-identifiable statistical unit before the record passes into the hands of the computer.[2]

Beyond the special collections of an individual laboratory there is already available a fair amount of published material. The United States has issued special censuses of the blind and of deaf-mutes. The Edinburgh Charity Organization Society has issued an excellent memoir on the home environment and the physique of 700 to 800 school children; above all, there are the registrar general's annual reports, the censuses, the reports of fever hospitals, of lunacy commissioners, and of the medical officers of asylums. Of some, but less value, are the reports of government commissions and the works of energetic, but statistically untrained, philanthropists like Charles Booth and Seebohm Rowntree. Important special researches, like that of Mr. Tocher on the insane of Scotland, or that now being carried out by Dr. Goring on

[2] The Eugenics Laboratory will gladly forward schedules (1) for general family history or (2) for special family abnormalities to any one interested in eugenic inquiry and willing to aid.

the convicts in his majesty's prisons, serve to increase the total data already available or nearly so. While all eugenics workers crave for more material, and for better quality of material, yet there already exists ample material upon which to base the beginnings for our science.

If we turn from material to method, we note that except in so far as results for animals have application to man, we can not experiment on individuals, and our methods must, therefore, be those applicable to mass-observations—that is to say, those actuarial methods applied to biological data which we now term the methods of biometry. It is not needful for me to enlarge now or here on those methods. Suffice it to say that they appear to measure effectively the relationship between factors which are not causally linked together. For the explanation of what follows I would state that the arithmetical value of a certain quantity—the so-called coefficient of correlation—is chiefly used to measure this relationship. Starting when the quantities are absolutely independent with zero value, it rises with their complete causal relationship to unity. Table I. shows the sort of values taken by this coefficient for various kinds of association, when the variates lack the absolute dependence of pure causation.

TABLE I.

CORRELATION COEFFICIENTS

High Correlation 1 *to* .75

Right and left femur in man	.98
Finger and forearm in man	.85
Foot and forearm in man	.80
Middle phalanges of middle and little finger	.76

Considerable Correlation .75 to .5

Weight and stature in woman	.72
Finger and stature in man	.66
Vaccination and recovery in cases of smallpox	.60
Weight and strength of pull in man	.55

Moderate Correlation .5 to .25

Forearms of two brothers	.49
Deviations in bank reserve and discount rate	.37
Coat color in horse and its grandsire	.30
High barometer in Portugal and low barometer in Norway	.27

Low Correlation .25 to .00

Resemblance of Aphis to its grandmother	.24
Size of family, mother and daughter	.21
Duration of lives, mother and daughter	.15
Length and breadth of Parisian skulls	.05

From method I turn finally to illustrate the nature of the conclusions which have already been reached by eugenic inquiry. As a preliminary, I must picture for you what I think evolution means in the case of human societies.

There was a time when, thinking over the marvelous intellectual,

artistic, and physical development of ancient Greece, I could wonder how still more ample it might have been had there existed a master spirit or an imperious motive to weld those statelets into one great nation and check the rarely ceasing internal wars and personal feuds. Looking back—from what some of you may consider a less ethical, but I believe a more scientific standpoint—I now see a direct correlation between the achievements of Greece and the intensity of its intertribal struggles. The *pax romana* did not provide the Greek spirit with an atmosphere as bracing to either bodily or spiritual development, as the instability and storm which accompanied the earlier conditions.

The struggle of man against man, with its victory to the tougher and more crafty: the struggle of tribe against tribe, with its defeat for the less socially organized: the contest of nation with nation whether in trade or in war, with the mastery for the foreseeing nation, for the nation with the cleaner bill of health, the more united purpose of its classes, and the sounder intellectual equipment of its units: are not these phases of the struggle for existence the factors which have made for human progress, which have developed man from brute into sentient being? We have been told that "the cosmic process is opposed to the ethical"! But from the standpoint of science, is not the ethical the outcome of the cosmic? Are not the physique, the intellectuality, the morality of man, the product of that grim warfare between individual and individual, between society and society, and between humanity and nature, of which we even yet see no end? The ethical as the product of the cosmic process will indeed aid us when we pass outside the field of science. But standing well within the boundaries of that field, are men to cry like little children because the world is not "as it ought to be"?

> Nach ewigen ehrnen
> Grossen Gesetzen
> Müssen wir alle
> *Unseres Daseyns*
> *Kreise vollenden.*

Nay, what has been rather man's method in mastering the physical universe? Has he not studied those brazen eternal laws, and guided the course of his being by that knowledge? Realize that the most valuable part of that knowledge is scarcely two hundred years old. And when we turn to biology—to the biological factors which control man's life and its relations to that of other organisms—are we not yet at the very dawn of discovery—a dawn whose actual storm-drifts foretell the coming flood of light?

Plato, in the Fifth Book of the "Laws," describes what he terms a purification or purgation of the state. Permit me for my weakness, not yours, to cite it from Jowett's translation:

> The shepherd or herdsman, or breeder of horses, or the like, when he has received his animals will not begin to train them until he has first purified them

in a manner which befits a community of animals; he will divide the healthy and unhealthy, and the good breed and the bad breed, and will send away the unhealthy and badly bred to other herds, and tend the rest, reflecting that his labors will be vain and without effect, either on the souls or bodies of those whom nature and ill-nurture have corrupted, and that they will involve in destruction the pure and healthy nature and being of every other animal, if he neglect to purge them away. Now, the case of other animals is not so important—they are only worth mentioning for the sake of illustration, but what relates to man is of the highest importance; and the legislator should make inquiries, and indicate what is proper for each in the way of purification and of any other procedure. Take, for example, the purification of a city—there are many kinds of purification, some easier and others more difficult; and some of them, and the best and most difficult of them, the legislator, if he be also a despot, may be able to effect; but he who, without a despotism, sets up a new government and laws, even if he attempt the mildest of purgations, may think himself happy if he can complete the work. The best kind of purification is painful, like similar cures in medicine, involving righteous punishment or inflicting death or exile in the last resort. For in this way we commonly dispose of great sinners who are incurable, and are the greatest injury to the whole state. But the milder form of purification is as follows: when men who have nothing, and are in want of food, show a disposition to follow their leaders in an attack on the property of the prosperous—these, who are the natural plague of the state, are sent away by the legislator in a friendly spirit as far as he is able, and this dismissal of them is euphemistically termed a colony. And every legislator should contrive to do this at once.

Now may we not claim Plato as a precursor of the modern eugenics movement? He grasped the intensity of inheritance, for he appeals to the herd and the flock; he realized the danger to the state of a growing band of degenerates, and he called upon the legislator to purify the state. Plato's purgation, if you will accept the view I have endeavored to lay before you to-day, has in fact hitherto been carried out by natural selection, by the struggle of man against man, of man against nature, and of state against state. This very cosmical process has so developed our ethical feelings that we find it difficult to regard the process as benign. A hundred years ago we still hung the greater proportion of our criminals or sent them for life across the seas, not even euphemistically terming it a "colony." We shut up our insane, making no attempt at cure; the modern system of hospitals and institutions and charities was scarcely developed; the physically and mentally weak had small chance of surviving and bearing offspring. There was a constant stern selection purifying in Plato's sense the state. The growth of human sympathy—and is not this one of the chief factors of national fitness?—has been so rapid during the century that it has cried Halt! to almost every form of racial purification. Is not this the real opposition which Huxley noticed between the ethical and cosmic processes? One factor—absolutely needful for race survival—sympathy, has been developed in such an exaggerated form that we are in danger, by suspending selection, of lessening the effect of those other factors which automatically purge the state of the degenerates in body and mind.

Do I therefore call for less human sympathy, for more limited charity, and for sterner treatment of the weak? Not for a moment:

we can not go backwards a single step in the evolution of human feeling! But I demand that sympathy and charity shall be organized and guided into paths where they will promote racial efficiency, and not lead us straight towards national shipwreck. The time is coming when we must consciously carry out that purification of the state and race which has hitherto been the work of the unconscious cosmic process. The higher patriotism and the pride of race must come to our aid in stemming deterioration; the science of eugenics has not only to furnish Plato's legislator with the facts upon which he can take action, but it has to educate public opinion until without a despotism he may attempt even the mildest purgation. To produce a nation healthy alike in mind and body must become a fixed idea—one of almost religious intensity, as Francis Galton has expressed it—in the minds of the intellectual oligarchy, which after all sways the masses and their political leaders.

Let me put before you a little more in detail the biological aspects of national growth. The Darwinian hypothesis asserts that the sounder individual has more chance of surviving in the contest with physical and organic environment. It is therefore better able to produce and rear offspring, which in their turn inherit its advantageous characters. Profitable variations are thus seized on by natural selection, and perpetuated by heredity.

Now if we are to apply these biological ideas to the case of man, we must have evidence (1) that man varies, (2) that these variations, favorable or unfavorable, are inherited, and (3) that they are selected.

Is it needful now to show that man varies? We not only know he varies, but the extent of variation in both man and woman has been measured by the biometric school in nearly two hundred cases. The variability within any single local race of man amounts from 4 or 5 to 15 to 20 per cent. of the absolute value of the character.

Secondly, are these variations inherited? Of this there is not the slightest doubt. They are not mere somatic fluctuations, but correspond to real geminal differences. The problem of inheritance is closely associated with that of the resemblance of members of the same stock, due caution being paid to the possibilities of environmental influence. Now we may separate the characters in which we are at present interested into three: (*a*) the physical, (*b*) the pathological and (*c*) the psychical.

Table II. gives us the resemblance between parent and offspring for a number of physical characters in man. Please note that the coefficient recorded is zero if there be no relationship and unity, if parent and offspring show an invariable relationship in the character under discussion. We see that the resemblance in the case of man lies between .4 and .5. It is about half-way up the correlation scale. Again the lower part of Table II. gives us corresponding measures of resemblance

between brethren for like characters; we notice that the resemblance lies between .5 and .6.

TABLE II.

INHERITANCE OF PHYSIQUE

Paternal Inheritance. Males Only

Method	Authority	Ages	Intensity
Family measurements:			
Stature	Pearson and Lee	Adults	.51
Span	" " "	"	.45
Forearm	" " "	"	.42
Family records:			
Eye color	" " "	"	.55
Fraternal Inheritance			
Family measurements:			
Stature	Pearson and Lee	Adults	.51
Span	" " "	"	.55
Forearm	" " "	"	.49
Family records:			
Eye color	" " "	"	.52
School observations:			
Eye color	Pearson	Boy and boy	.54
School measurements:[3]			
Head breadth	"	" " "	.59
Head length	"	" " "	.50
Head height	"	" " "	.55
Cephalic index	"	" " "	.49

Mean paternal value, .48. Mean fraternal value, .53.

For both parental and fraternal inheritance in man we find for physical characters much the same values as we find in the cases of cattle, horses and dogs. This is illustrated in Table III.

TABLE III.

PARENTAL INHERITANCE IN DIFFERENT SPECIES

Species	Character	Mean Value	No. of Pairs used
Man	Stature	.51	4,886
	Span	.48	4,873
	Forearm	.42	4,866
	Eye color	.50	4,000
Horse	Coat color	.52	4,350
Basset hound	Coat color	.52	823
Greyhound	Coat color	.51	9,279
Aphis	Right antenna / Frontal breadth	.44	368
Daphnia	Protopodite / Body length	.47	96
Mean	—	.48	

Turning now to diseased or pathological cases, we have at present only three types that have been dealt with. These are Mr. Edgar

[3] Reduced to standard age of twelve years.

Schuster's results for the inheritance of deaf-mutism; Mr. Heron's results for the inheritance of the insane diathesis, and my own work on pulmonary tuberculosis. It is worth noting that these results are all first-fruits of Mr. Galton's foundation of a eugenics laboratory.

TABLE IV.

PATHOLOGICAL INHERITANCE

Condition	Investigator	Parental	Fraternal
Deaf-mutism	Schuster	.54	.73
Insanity	Heron	.58	.48
Pulmonary tuberculosis	Pearson	.50	.48
Mean value	——	.54	.56

Now it must be admitted at once that these diseased states are far harder to deal with than simple quantitative characters. Their treatment involves more assumptions, and the data are less trustworthy.

TABLE V.

SCHOOL OBSERVATIONS. RESEMBLANCE OF SIBLINGS

Physical Characters

Character	Boys	Girls	Boy and Girl
Health	.52	.51	.57
Eye color	.54	.52	.53
Hair color	.62	.56	.55
Curliness	.52	.52	.52
Cephalic index	.49	.54	.43
Head length	.50	.43	.46
Head breadth	.59	.62	.54
Head height	.55	.52	.49
Mean	.54	.53	.51

TABLE VI.

SCHOOL OBSERVATIONS. RESEMBLANCE OF SIBLINGS

Psychical Characters

Character	Boys	Girls	Boy and Girl
Vivacity	.47	.43	.49
Assertiveness	.53	.44	.52
Introspection	.59	.47	.63
Popularity	.50	.57	.49
Conscientiousness	.59	.64	.63
Temper	.51	.49	.51
Ability	.46	.47	.44
Handwriting	.53	.56	.48
Mean	.52	.51	.52

But from what I show in this table I think we may safely draw two conclusions: (*a*) the tendency to diseases of mind and body is inherited; (*b*) this inheritance may be slightly greater, it is hardly likely to be less, than the inheritance of quantitatively measurable physical characters.

I now turn to the inheritance of the psychical characters. Here again we tread on more difficult ground. On first investigating the problem myself I worked with school children, and for the following reasons. The teacher compares the individual with his general experience of many children; he thus approaches much more nearly an absolute standard than if we ask for an isolated return as to a single family from this or that relatively inexperienced recorder. Secondly, it is not often that we can find any data of the psychical characters of father and son taken at about the same period in life. If you will look at Tables V. and VI. and Fig. 3 you will see that I have not been able to discover any difference in intensity of inheritance between the psychical and physical characters in children.[4] Mr. Schuster has been able to get over my difficulty at least for one character, that of ability in father and son as judged by the Oxford Class Lists. In a recent memoir published by the Galton Eugenics Laboratory he obtains the results given in Table VII. If we allow for an academic selection of intelligence, we reach values singularly close to those obtained for the physical characters. I have added some results of my own, not hitherto published, taken from my family record schedules. To sum up, there appears no doubt that good and bad physique, the liability to and the immunity from disease, the moral characters and the mental temperament, are inherited in man and with much the same intensity.

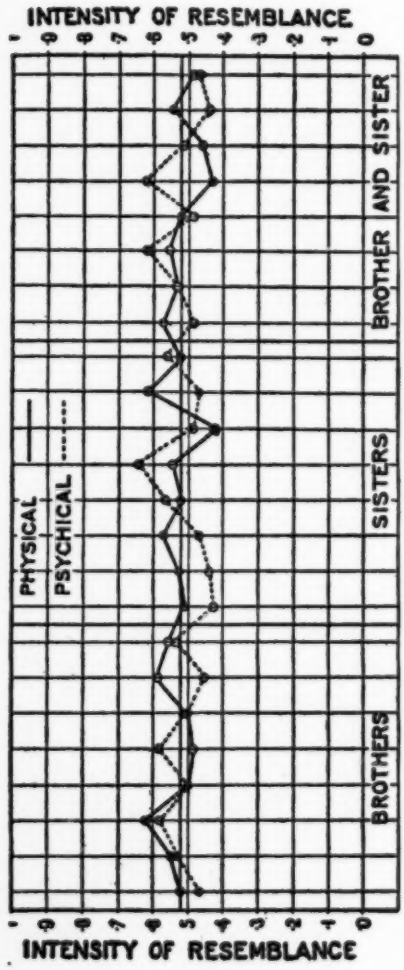


FIG. 3. COMPARISON OF RESEMBLANCE FOR PHYSICAL AND PSYCHICAL CHARACTERS.

As a next stage, I point out—if it be needful to do so—that Figs. 4 and 5 show that those who live longest, and may be presumed to be

[4] The tables reproduced here are drawn from my Huxley lecture or other biometric memoirs.

TABLE VII.

INHERITANCE OF ABILITY. MALE AND MALE

Paternal Inheritance

Method	Authority	Ages	Intensity
Oxford class lists	Schuster	Adults	.49
Family records	Pearson	Adults	.58

Fraternal Inheritance

Oxford class lists	Schuster	Adults	.56
Family records	Pearson	Adults	.54
School class lists	Schuster	Boys	.56
School observations	Pearson	Boy and boy	.52

Mean paternal value, .54. Mean fraternal value, .54.

the healthiest, leave most offspring.[5] One link still remains unproven: Are these variations subject to selection? Is the death rate in man a function of his constitution? Or does man fall in his youth or prime or dotage by the purely random bolt of death? The possibility of

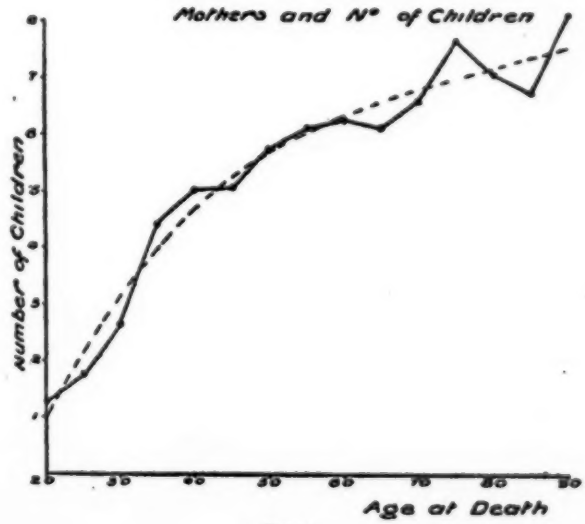


FIG. 4.

solving this last problem occurred to me when studying the inheritance of longevity. If longevity depended only on the physical constitution, we might expect it to be inherited at the same rate as other physical characters. I found it to be inherited always at a *lesser* rate. The difference could only be accounted for by the partly random character of death's aim. This was the key to measuring the proportion of the selective and non-selective death rates in man. Table VIII. gives you

[5] The data are from the records of the Society of Friends, and show with little doubt an *unrestricted* birth rate.

the results. With these results it appears to me that Darwinism is clearly and definitely established for man.

It is not so many years ago since a distinguished statesman, speaking within the walls of this university, asserted that, "No man has ever seen natural selection at work." At that time all the criticism

FIG 5.

possible seemed, "Every man who has lived through a hard winter, every man who has examined a mortality table, every man who has studied the history of nations, has *probably* seen natural selection at work." And thirteen years later I should add: The time has now come for statesmen to inquire whether natural selection is doing its work efficiently; that it applies to man no longer admits of question. Can it possibly be that agencies under the control of the legislator are suspending that Platonic purification of the state which in olden time natural selection worked almost automatically?

TABLE VIII.

NATURAL SELECTION IN MAN. PERCENTAGES OF DEATHS DUE TO SELECTIVE DEATH RATE

Deduced from Age at Death of Kindred

From Parental Heredity Data			From Fraternal Heredity Data		
Value	Selected %	Non-selected	Value	Selected %	Non-selected
.3	67.5	32.5	.4	84.1	15.9
.4	58.4	41.6	.45	79.3	20.7
.45	55.1	44.9	.5	75.2	24.8

Thus between 55 and 75 per cent. of deaths in the case of man are selective.

This is the next point concerning which eugenics may have something to tell us. In order that natural selection should be suspended, it is not sufficient to reduce the selective death rate; it is necessary that the relative fertility of the unfit should be higher than that of the fit. If the unfit variations leave to any state their heritage of unfitness, what can save that state from degeneracy, what hinder a catastrophe when that state has to prove its only title-deed to seizin of the earth?

TABLE IX.

FERTILITY IN PATHOLOGICAL AND NORMAL STOCKS

Pathological

	Authority	Nature of Marriage	Size of Family
Deaf-mutes, England	Schuster	Probably completed	6.2
Deaf-mutes, America	Schuster	" "	6.1
Tuberculous stock	Pearson	" "	5.7
Albinotic stock	Pearson	" "	5.9
Insane stock	Heron	" "	6.0
Edinburgh degenerates	Eugenics Lab.	Incomplete	6.1
London mentally defective	" "	"	7.0
Manchester mentally defective	" "	"	6.3
Criminals	Goring	Completed	6.6

Normal

English middle class	Pearson	15 years at least—begun before 35	6.4
Family records	Pearson	Completed	5.3
English intellectual class	Pearson	All completed marriages	4.7
Working class N. S. W.	Powys	Completed	5.3
Danish professional class	Westergaard	15 years at least	5.2
Danish working class	Westergaard	25 years at least	5.3
Edinburgh normal artizan	Eugenics Lab.	Incomplete	5.9
London normal artizan	" "	"	5.1
American graduates	Harvard	Completed?	2.0
English intellectuals	S. Webb	Said to be completed	1.5

All childless marriages are excluded except in the last two cases. Inclusion of such marriages usually reduces the average by ½ to 1 child.

In Table IX. I have placed the fertility of deaf-mute, tuberculous, criminal and insane stocks, and below them the fertility of more normal classes in the community. It is at once obvious that degenerate stocks under present social conditions are not short-lived, they live to have more than the normal size of family. Natural selection is largely suspended, but not the inheritance of degeneracy nor the fertility of the unfit. On the contrary, there is more than a suspicion of the suspension of the fertility of the fit. If further evidence be needful, look at the results in Table X. for the correlation between all that makes for unfitness and the number of children per married woman under fifty-five. Mr. Heron has indeed shown us that the survival of the unfit is a marked characteristic of modern town life. Every condition

which makes for bad nurture as well as bad nature seems to emphasize the birth rate.

As we have found conscientiousness is inherited, so I have little doubt that the criminal tendency descends in stocks. To-day we feed our criminals up, and we feed up the insane, we let both out of the prison or the asylum "reformed" or "cured" as the case may be, only after a few months to return to state supervision, leaving behind them the germs of a new generation of deteriorants. The average number of crimes due to the convicts in his majesty's prisons to-day is ten apiece. We can not reform the criminal, nor cure the insane

TABLE X.

CORRELATION OF BIRTH RATE MEASURED ON WIVES OF REPRODUCTIVE AGES WITH SOCIAL AND PHYSICAL CHARACTERS OF POPULATION OF LONDON

For 1901 Census. David Heron

Characters Correlated	Correlation Coefficient
Birth Rate	
With males engaged in professions	−.78
With female domestics per 100 females	−.80
With female domestics per 100 families	−.76
With general laborers per 1,000 males	+.52
With pawnbrokers and general dealers per 1,000 males	+.62
With children employed, ages 10–14	+.66
With persons living more than 2 in a room	+.70
With infants under 1 year dying per 1,000 births	+.50
With death from phthisis per 100,000	+.59
With total number of paupers per 1,000	+.20
With number of lunatic paupers per 1,000	+.34
Infant Mortality	
With children aged 2–4	+.59
" " 5–14	+.54
" " 13–15	+.34
(per 100 wives)	

These last results show that the infantile mortality of the fertile classes does not compensate for their predominant fertility.

from the standpoint of heredity; the taint varies not with their moral or mental conduct. These are products of the somatic cells; the disease lies deeper in their germinal constitution. Education for the criminal, fresh air for the tuberculous, rest and food for the neurotic —these are excellent, they may bring control, sound lungs, and sanity to the individual; but they will not save the offspring from the need of like treatment, nor from the danger of collapse when the time of strain comes. They can not make a nation sound in mind and body, they merely screen degeneracy behind a throng of arrested degenerates. Our highly developed human sympathy will no longer allow us to watch the state purify itself by aid of crude natural selection. We see pain and suffering only to relieve it, without inquiry as to the moral character of the sufferer or as to his national or racial value. And this is right—no man is responsible for his own being; and nature and

nurture, over which he had no control, have made him the being he is, good or evil. But here science steps in, crying:

> Let the reprieve be accepted, but next remind the social conscience of its duty to the race. No nation can preserve its efficiency unless dominant fertility be associated with the mentally and physically fitter stocks. The reprieve is granted, but let there be no heritage if you would build up and preserve a virile and efficient people.

Here, I hold, we reach the kernel of the truth which the science of eugenics has at present revealed. The biological factors are dominant in the evolution of mankind; these, and these alone, can throw light on the rise and fall of nations, on racial progress and national degeneracy. In highly civilized states, the growth of the communal feeling—upon which indeed these states depend for their very existence—has not kept step with our knowledge of the laws which govern race development. Consciously or unconsciously we have suspended the racial purgation maintained in less developed communities by natural selection. We return our criminals after penance, our insane and tuberculous after "recovery," to their old lives; we leave the mentally defective flotsam on the flood-tide of primordial passions. We disregard on every side these two great principles: (*a*) the inheritance of variations, and (*b*) the correlation in heredity of unlike imperfections.[6] The statesman, as usual, is inert, waiting for the growth of popular opinion. Doctors, we are told, do not believe in heredity. If that be so, they have small idea of the most plentiful harvest yet reaped by modern science. The philanthropist looks to hygiene, to education, to general environment, for the preservation of the race. It is the easy path, but it can not achieve the desired result. These things are needful tools to the efficient, and passable crutches to the halt; but at least on one point Mendelian and biometrician are in agreement—there is no hope of racial purification in any environment which does not mean selection of the germ.

If I speak strongly, it is because I feel strongly; and the strength of my feeling does not depend on the few facts I have brought before you to-day. It would be possible to paint a lurid picture—and label it race-suicide. That is feasible to any one who has seen, even from afar, the nine circles of that dread region which stretches from slum to reformatory, from casual ward and stew to prison, from hospital and

[6] We are at present only reaching light on what is a very important principle, namely, that stocks exist which show a general tendency to defect, taking one form in the parent, another in the offspring. Neuroses in the parents become alcoholism or insanity in the offspring; mental defect may be correlated with tuberculosis, albinism with imbecility; and one type of visual defect in the father be found associated with a second in the son. We can not at present give this fact scientific expression, but it would appear that there is something akin to germinal degeneracy which may show itself in different defects of the same organ or in defects of different organs. The solution, perhaps, lies in a tendency to general defect in the gamete. Even now, I doubt whether it is absolutely unscientific to speak of a general inheritance of degeneracy.

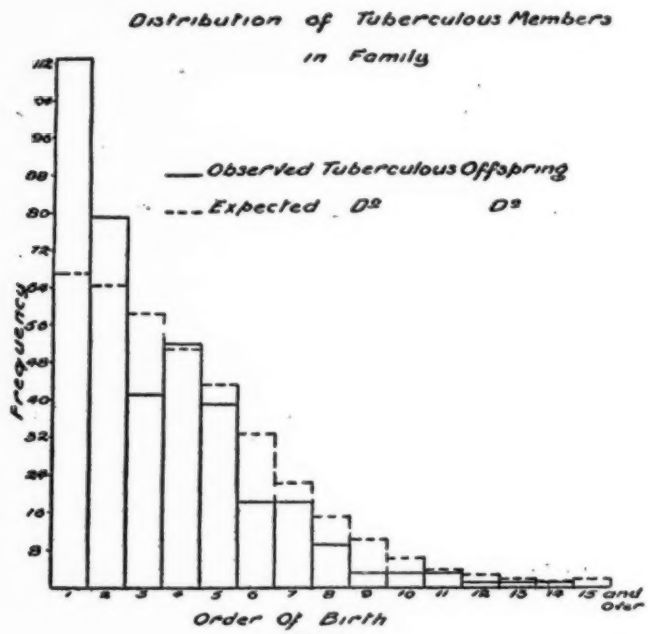


FIG. 6, a.

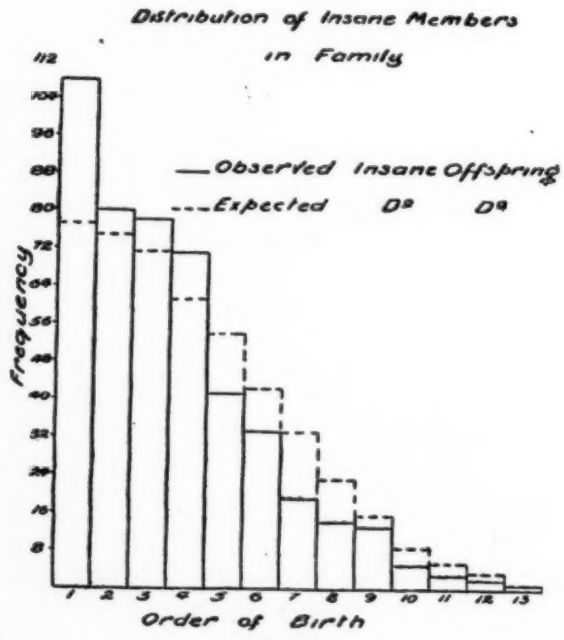


FIG. 6, b.

sanatorium to asylum and special school; that infernal lake which sends its unregarded rivulets to befoul more fertile social tracts. But the scope of eugenics is not to stir the social conscience by an exaggerated

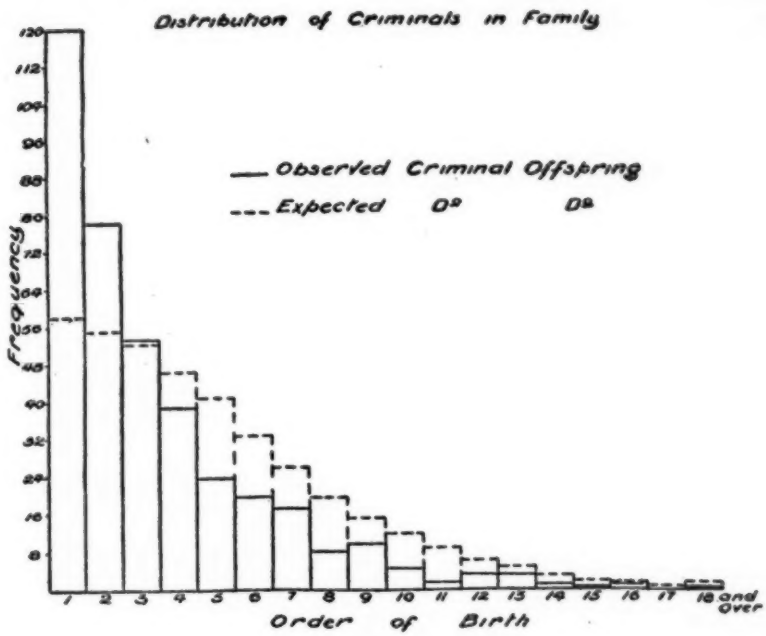

Distribution of Criminals in Family
Observed Criminal Offspring
Expected
Frequency
Order of Birth
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 and over

FIG. 6, c.

picture of racial dangers. Those dangers are not wholly recent, if they are increasing in intensity; they are not peculiar to England, as a brief acquaintance with French and German conditions will suffice to show. Nay, even in the new world men are awaking to the peril which high civilizations risk from their treatment of degenerates. What we leave to private effort, the establishment of a eugenics laboratory, they propose in the United States to do by a government office. The American proposal to establish a laboratory in the Department of the Interior for the study of the abnormal classes and the collection of sociological and pathological data, has only one, but that a grave defect. No eugenics laboratory which confines its attention to the study of the abnormal can fulfil its functions. The positive side is as important as the negative side, and the application of the laws of inheritance to the betterment of the good is as vital as and far more likely to inspire us with hope of achievement than concentrating our investigations on the excision of the bad.

If we realize the antinomy which eugenics brings to our notice between high civilization and racial purgation, we ask: How can the dominant fertility of the fitter social stocks be maintained when natural selection has been suspended? I do not think any wise man would be prepared with a full answer to this question to-day. There is no sovereign remedy for degeneracy. Every method is curative which tends to decrease the fertility of the unfit and to emphasize that of the fit.

We may find it difficult to define the socially fit, although physique and ability will carry us far; but when we turn to the habitual criminal, the professional tramp, the tuberculous, the insane, the mentally defective, the alcoholic, the diseased from birth or from excess, there can be little doubt of their social unfitness. Here every remedy which tends to separate them from the community, every segregation which reduces their chances of parentage, is worthy of consideration. Strange as it may seem, we are not much beyond the cure suggested by Plato—what is "euphemistically termed a colony," for the degenerates of each sex. The duty of the man of science is to find out the law, and if possible waken the conscience of his countrymen to its existence. It is the function of the statesman to discover the feasible social remedy which is not at variance with that law.

But, thus far, I have touched on only one side of the problem, the reduction in bad stock. Is not something more to be insisted upon with regard to the increase of good stock? Have we not treated the birth of children as something that concerned the individual and not the state? May not a source of racial greatness lie in a national spirit, like that of Japan, which demands the healthy able child from fitting parents, and looks with sinister eye on those who provide the state with the halt and diseased? I may have overlooked the point, but I have not noticed that this first principle of duty to the race, of national morality, has been fully insisted upon by our ethical writers. I have often heard false pride of ancestry condemned, but I have not seen the true pride of ancestry explained and commended. Surely the man who is conscious that he comes of a stock sound in body, able in mind, tested in achievement, and who knows that, mating with like stock and maintaining himself in health, he will hand down that heritage to his children—surely such a man may have a legitimate pride in ancestry, and is worthy of honorable mention in eugenic records? It seems to me that those who have the welfare of the nation, and our racial fitness for the world-struggle, at heart must recognize that this is the ideal which the racial conscience demands of its saner members.

A clean body, a sound if slow mind, a vigorous and healthy stock, a numerous progeny, these factors were largely representative of the typical Englishman of the past; and we see to-day that one and all these characteristics can be defended on scientific grounds; they are the essentials of an imperial race.

As we have found an antinomy between high civilization and race purification by natural selection, so there appears to be a corresponding antagonism between individual comfort and race welfare. It is again the tendency of higher civilization to suspend the more drastic phases of the struggle for existence and the survival of the fitter. The man of education, or made position, says "the chances of my children are better if I have but few of them," and we reach the startling condition

of America, where the classes of ability—the classes which take as their standard an academic education—are not reproducing themselves, their average number of offspring being less than two; we reach the state of affairs which Mr. Sydney Webb tells us is demonstrable in another intellectual circle in this country, an almost childless population of non-inherited ability. And against this we have to set the maximum fertility which is reached by the degenerate stocks! Individual welfare and race welfare, are they really as opposed as they appear? Is it true insight to consider that the fewer children the better is their prospect in life? I can not think that the time has come when the family is no longer an effective social unit. Is the family of two really in a stronger condition to face the world? Is there not mutual help and strength in kinship, and as age comes on must the old and feeble be left to the care of strangers? Eugenically Mr. Powys, in his fine memoir on fertility and duration of life in New South Wales,[7] has shown that in Australia the longest-lived women are the mothers neither of small nor of inordinately large families. They are the mothers of five to six children. Eugenically we have shown that the two or three first-born members of a family are more liable to insanity (Heron), tuberculosis (Pearson), criminality (Goring) and mental defect.[8] Fig. 6 will illustrate this. The excess of pathological cases among the earlier born is very significant. Economically, is it not true that if six degenerates are born to two, and not six, sound men and women, those two will have to do triple work to provide—in prison, asylum, institution and hospital—for this mass of the incompetent? I am not sure that a strong case could not be made out against the small family even on the basis of individual welfare! But I would rather appeal on this point to race instinct and to the social conscience. The progress of the race inevitably demands a dominant fertility in the fitter stocks. If that principle be not recognized as axiomatic by the mentally and bodily fit themselves, if the statesman does not accept it as a guide in social legislation, then the race will degenerate, until, sinking into barbarism, it may rise again through the toilsome stages of purification by crude natural selection. I am not pessimistic in this attitude. I know that the English people has been aroused to self-consciousness more than once in its history, and I believe that now it can be brought to realize that safety lies in a conscious race-culture. If race feeling can be appealed to by men trained to see the bearing of great biological laws on human growth, then we shall not create a mere passing wave of national emotion conveniently satisfied by the appointment, dead before the report, of a royal commission. The time seems upon us when the biological sciences shall begin to do for man what the

[7] *Biometrika*, Vol. IV., pp. 233–92.

[8] It seems to me that here science has a word to say with regard to reform of a hereditary peerage.

physical have done for more than a century; when they shall aid him in completing his mastery of his organic development, as the physical sciences have largely taught him to control his inorganic environment. To bring this about we need above all two factors. First: a knowledge of inheritance, variation, selection and fertility in man, and the relation of these results to racial efficiency. To this special branch of biology, Francis Galton has given the name of the science of national eugenics, and in founding the Francis Galton Laboratory for National Eugenics in the University of London he has been the pioneer in asserting that even from the academic standpoint "the proper study of mankind is man." Eighty years ago there were no physical laboratories in the universities of this country, sixty years ago there were no physiological laboratories, thirty years ago there were no engineering laboratories. To-day there is only one laboratory for national eugenics. I believe that every university twenty years hence will offer its students training in the science that makes for race-efficiency and in the knowledge which alone can make a reality of statecraft. The eugenics laboratory then will require no apology, it will be too well recognized a part of university equipment. The second factor which seems to me needful is an altered tone with regard to those phases of our sexual life upon which the health and welfare of the nation as a whole so largely depend. In this matter I think we can learn from the spirit of our youngest allies, the Japanese, and from the practise of our oldest allies, the Jews. With both, race-preservation and race-betterment have assumed the form of a religious cult. And one aim of my lecture to-day is that I may appeal to the younger members of my audience, on whom responsibility for forming opinion will shortly fall, to weigh these things well, for they touch closely our national safety. On the one hand, I do not raise an alarmist picture of our coming decadence, nor, on the other hand, would I leave you without insisting that there is grave occasion for earnest thought. I would raise interest in a new and, I believe, potent branch of science; I would call for a strengthening of racial conscience, and a scientific basis for conduct, as our growing civilization stems natural selection as the purifier of the state. Thus it is that eugenics passes from science into practise, from knowledge to a creed of action. This can not be expressed better than by Francis Galton's concluding words in his "Eugenics as a Factor of Religion":

> Eugenic belief extends the function of philanthropy to future generations, it renders its actions more pervading than hitherto, by dealing with families and societies in their entirety, and it enforces the importance of the marriage covenant by directing serious attention to the probable quality of the future offspring. It sternly forbids all forms of sentimental charity that are harmful to the race, while it eagerly seeks opportunity for acts of personal kindness, as some equivalent to the loss of what it forbids. It brings the tie of kinship into prominence and strongly encourages love and interest in family and race. In brief, eugenics is a virile creed, full of hopefulness, and appealing to many of the noblest feelings of our nature.

PETER KALM'S "TRAVELS"

By SPENCER TROTTER
SWARTHMORE COLLEGE

A STUDENT of our early colonial history once remarked to me that we should have lived some two hundred years before our time, then we might have thoroughly enjoyed the country. By "country" he meant the natural, primitive condition of the land as it appeared to the first generation of Europeans born on its shores. It was far from being the inhospitable wilderness that their fathers had known. Homes of some comfort stood in the midst of cleared land; the fields yielded an abundant harvest; flourishing young towns and the king's highway gave to the new country a semblance of old-world civilization. And yet, withal, the ancient woods and the wild life were but a bow-shot from its door-steps.

This observation of my friend makes a strong appeal to the imagination of those of us who love simple ways and nature undisturbed. We may voice the poet's regret that

> The world is too much with us,

but in truth it would doubtless be a great hardship if we should find ourselves, by some trick of a fairy godmother, back in those primitive days. A man's life is so largely made up of the things of the mind that it is the picture of the thing that makes for happiness far more than the reality.

The past is a fine canvas for our pictures. The pigments of fancy blend in pleasing effects, and distance in time as well as in space lends its enchantment. Many things are potent to suggest these pictures—the faded leaves of a diary, a bit of finery, the site of some long-forgotten house, an old book—trifles light as air that turn the hard lines of a modern scene into the soft, hazy light of the past.

The peculiar charm of an old book is the atmosphere that pervades it. Its pages may contain nothing of interest, even to the most curious reader, but with the lapse of time the dullest volume acquires a certain distinctive character. An old book breathes of the past; the scent of its stained and musty leaves penetrates into the dim chambers of the mind where fancy slumbers. And when fancy stirs and awakens its neighbor, long-forgotten memory, mayhap we have here the reason for this endearing quality of old things, for who knows what shreds of ancestral memories were wrapped in the bundle of our inheritances.

This flotsam and jetsam of the literary past, drifted on to the upper shelves and into out-of-the-way places, may yield some bit of treasure —some record vivid with the life of old days and of places long since blotted out.

Among such driftwood is occasionally to be found a rare fragment of Americana—the "Travels into North America," by Peter Kalm. It is a quaint old book with the observations and reflections of an inquisitive naturalist who visited this country in the middle of the eighteenth century. There is no attempt at style or literary finish of any sort—it is the plain narrative of a man whose interests were by no means confined to natural history. The book is charming in the desultory treatment of its subject matter—in its utter lack of logical arrangement. In one place we read of "cyder" making, and in the very next paragraph the author abruptly launches forth in a dissertation on "a certain quadruped which is pretty common, not only in *Pensylvania,* but likewise in other provinces, both of *South* and *North America,* and goes by the name of *Polecat* among the *English.* In *New York* they generally call it *Skunk.*" In another place some peculiarity in the marriage of widows is followed by a dissertation on divers remedies used against the toothache.

Kalm was omnivorous as to facts. He meant to tell everything about the new country, and sets this forth in the following remarkable title—

TRAVELS
INTO
NORTH AMERICA;
CONTAINING
ITS NATURAL HISTORY, AND
A circumstantial Account of its Plantations
and Agriculture in general,
WITH THE
CIVIL, ECCLESIASTICAL AND COMMERCIAL
STATE OF THE COUNTRY,
The MANNERS of the INHABITANTS, and several curious
and IMPORTANT REMARKS on various Subjects.

A perusal of the book fully justifies this title. One is convinced that "no circumstance interesting to natural history or to any other part of literature has been omitted." The book was first published at Stockholm in 1753 under the title "En Resa Til Norra America," and it was subsequently translated into both German and English. The English translation, edited by the naturalist, John Reinhold Forster, was first published at London in 1772, in three volumes, and is dedicated to the Hon. Daines Barrington, the same to whom Gilbert White of Selborne addressed so many of his letters.

Kalm, who held the position of "Professor of Œconomy in the Uni-

versity of Aobo in Swedish Finland," was sent out at the instance of the Royal Academy of Sciences at Stockholm to make "such observations and collections of seeds and plants as would improve the *Swedish* husbandary, gardening, manufactures, arts and sciences." Iceland and Siberia were first proposed as the countries to be explored for this purpose, but Linnæus "thought that a journey through *North America* would be yet of more extensive utility." What Sweden gained by this change of plan we do not know, but the literary and scientific world of that day gained much, and we of to-day—lovers of old books and quaint recitals—find great store of pleasure in these pictures of the past.

Kalm's book is full of local color and redolent of the soil and the air of the country. The simplicity and directness of statement put one at once in sympathy with the man. His personality is in every page, but there is no striking of the literary attitude. He is entirely simple-minded, almost child-like—a gentle, companionable man. Listen to this naïve rehearsal on the first day of his setting foot ashore at Philadelphia:

> I found that I was now come into a new world. Whenever I looked to the ground, I everywhere found such plants as I had never seen before. When I saw a tree, I was forced to stop, and ask those who accompanied me, how it was called. The first plant which struck my eyes was an *Andropogon*, or a kind of grass, and grass is a part of Botany I always delighted in. I was seized with terror at the thought of ranging so many new and unknown parts of natural history. . . . At night I took up lodging with a grocer who was a quaker, and I met with very good, honest people in this house, such as most people of this profession appeared to me; I and my *Yungstraem*, the companion of my voyage, had a room, candles, beds, attendance, and three meals a day, if we chose to have so many, for twenty shillings per week in *Pensylvania* currency. But wood, washing and wine, if required, were to be paid for besides.

Kalm had numerous letters of recommendation—

> Mr. *Benjamin Franklin*, to whom *Pensylvania* is indebted for its welfare, and the learned world for many new discoveries in electricity, was the first who took notice of me, and introduced me to many of his friends. He gave me all necessary instructions, and shewed me his kindness on many occasions.

A Swede himself, Kalm naturally spent much of his time among the Swedes, descendants of the first Swedish settlers on the Delaware. At the village of Raccoon on the New Jersey shore, he sojourned with his brethren for many weeks during the winter and spring of 1749. The village has long since disappeared; the place where it once stood is now not certainly known, but Raccoon Creek still falls into the Delaware, nearly opposite the Pennsylvania town of Chester, and the searcher after old sites may spend some pleasant hours, if only with the haunting sense of the vanished hamlet that once stood somewhere in this neighborhood. Here Kalm gained much information from the

mouths of old Swedes who remembered the land in the earlier days of its settlement.

The first houses that the Swedes built consisted of but one little room, with the door so low that one had to stoop in order to get in. "As they had brought no glass with them, they were obliged to be content with little holes, before which a movable board was fastened." The cracks and crannies were stopped with clay. Clay was also used, in many instances, in the construction of their chimneys.

Before the *English* came to settle here, the *Swedes* could not get as many cloaths as they wanted; and were therefore obliged to make shift as well as they could. The men wore waistcoats and breeches of skins. Hats were not in fashion; and they made little caps, provided with flaps before. They had worsted stockings. Their shoes were of their own making. Some of them had learnt to prepare leather, and to make common shoes with heels; but those who were not shoemakers by profession, took the length of their feet, and sewed the leather together accordingly; taking a piece for the sole, one for the hind-quarters, and one more for the upper-leather. At that time, they likewise sowed flax here, and wove linen cloth. Hemp was not to be got; and they made use of flaxen ropes and fishing tackle. The women were dressed in jackets and petticoats of skins. Their beds, excepting the sheets, were skins of several animals; such as bears, wolves, etc.

Such "superfluities" as tea, coffee and chocolate were unknown to these first settlers on the Delaware, but rum they had at "moderate price" and "sugar and treacle they had in abundance. . . . Almost all the *Swedes* made use of baths; and they commonly bathed every *Saturday*." Their carts must have been remarkable constructions, the wheels sawed from thick pieces of the liquidambar tree.

These old Swedes had a small idea of the value of land and sold large tracts to English settlers for a mere song. One old Swede told Kalm that his father sold an estate, which at the time of Kalm's visit was reckoned at three hundred pounds value, "for a cow, a sow and a hundred gourds."

Kalm was evidently much impressed by the spirit of liberty that prevailed amongst the people. Speaking of the decrease of certain wild birds, as compared with their former abundance, he says:

But since the arrival of great crowds of *Europeans*, things are greatly changed; the country is well peopled, and the woods are cut down; the people increasing in this country, they have by hunting and shooting in part extirpated the birds, in part scared them away; in spring the people still take both eggs, mothers and young indifferently, because no regulations are made to the contrary. And if any had been made, the spirit of freedom which prevails in the country would not suffer them to be obeyed.

In another place he refers to the freedom displayed in taking fruit from the orchards.

The orchards, along which we passed today, were only enclosed by hurdles. But they contained all kinds of fine fruit. We wondered at first very much

when our leader leaped over the hedge into the orchards, and gathered some agreeable fruit for us. But our astonishment was still greater when we saw that the people in the garden were so little concerned at it, as not even to look at us. But our companion told us, that the people here were not so exact in regard to a few fruits, as they were in other countries where the soil is not so fruitful in them. We afterwards found very frequently that the country people in *Sweden* and *Finland* guarded their turnips more carefully, than the people here do the most exquisite fruits.

Among the many customs of the people which Kalm noted are the following curious passages relating to marriage—

There is a great mixture of people of all sorts in these colonies, partly of such as are lately come over from *Europe*, and partly of such as have not yet any settled place of abode. Hence it frequently happens that when a clergyman has married such a couple, the bridegroom says he has no money at present, but would pay the fee at the first opportunity; however, he goes off with his wife, and the clergyman never gets his due. This proceeding has given occasion to a custom which is now common in *Maryland*. When the clergyman marries a very poor couple, he breaks off in the middle of the *Liturgy*, and cries out, *Where is my fee?* The man must then give the money, and the clergyman proceeds; but if the bridegroom has no money, the clergyman defers the marriage till another time, when the man is better provided. People of fortune, of whom the clergyman is sure to get his due, need not fear this disagreeable question, when they are married. . . . There is a very peculiar diverting custom here, in regard to marrying. When a man dies, and leaves his widow in great poverty, or so that she can not pay all the debts with what little she has left, and that, notwithstanding all that, there is a person who will marry her, she must be married in no other habit than her shift. By that means, she leaves to the creditors of the deceased husband her cloaths, and everything which they find in the house. But she is not obliged to pay them anything more, because she has left them all she was worth, even her cloaths, keeping only a shift to cover her, which the laws of the country cannot refuse her. As soon as she is married, and no longer belongs to the deceased husband, she puts on the cloaths which the second has given her. The *Swedish* clergymen here have often been obliged to marry a woman in a dress which is so little expensive, and so light.

There are various references in Kalm's book to the aboriginal inhabitants of the country, though at the time of his visit the Indians had retired from the immediate vicinity of the seaboard. "It is very possible," says Kalm, "for a person to have been at *Philadelphia* and other towns on the sea shore for half a year together, without so much as seeing an *Indian*." Most of Kalm's observations concerning the natives, their manners, customs and food, are at second hand, but may be regarded as fairly reliable, his information being obtained from the older Swedes, who, in the earlier days of the settlement, had been well acquainted with the Indian people that dwelt by the Delaware.

What pleases the reader most in Kalm's book, I think, is the general picture of the country and the local color which he gets from the scattered observations and descriptions throughout the pages. Naturally Kalm was much impressed with the extent of forest in this new

world. Furthermore he was a botanist, and had an eye for the various kinds of trees, the remarks upon which, and upon the great variety of plants that he observed and collected, occupy a considerable portion of the narrative. He tells us in one place that grass formerly grew in the woods which were then quite open, with little or none of the underwood growth which characterize our woodlands to-day. The settled parts of the country must have had a wild and shaggy look, even in Kalm's time, for he speaks of the stumps of trees in the corn-fields—a real backwoods' picture—and notes that the farms were widely separated from one another:

The greatest part of the land, between these farms so distant from each other, was overgrown with woods, consisting of tall trees. However, there was a fine space between the trees, so that one could ride on horseback without inconvenience in the woods, and even with a cart in most places; and the ground was very plain and uniform at the same time. . . . In some parts of the country the trees were thick and tall, but in others I found large tracts covered with young trees, only twenty, thirty, or forty years old; these tracts, I am told, the *Indians* formerly had their little plantations in. . . . The woods consisted chiefly of several species of oak, and of hiccory.

An old Swede, Nils Gustafson by name, ninety-one years of age, told Kalm that

he could very well remember the state of the country, at the time when the *Dutch* possessed it, and in what circumstances it was before the arrival of the *English*. He added, that he had brought a great deal of timber to *Philadelphia*, at the time it was built. He still remembered to have seen a great forest on the spot where *Philadelphia* now stands.[1]

Kalm had a practical turn of mind. Being a professor of "Œconomy," he was at all times on the look-out for the uses of things. Whatever contributed to human welfare seemed to him of the first moment. What a particular plant or tree yielded in the way of dyes, or food, or timber, or remedies against sickness; the nature of soils, the qualities of rocks and stones for building purposes; the thrift, or want of it, on the part of the people; how they clothed and housed themselves; how prolific they were, what they ate, how they cooked their food, how they cared for their stock and crops—all such matters find a conspicuous place in his pages. And so he goes rambling delightfully on—describing and commenting upon everything that he saw, or even heard of—here about wine-making, or fences, or spring-houses; there about some curious custom, or remarkable occurrence. He was forever putting a question—"quere," as he called it—"where did the Swedes here settled get their several sorts of corn, and likewise their fruit-trees and kitchen-herbs?" "Whence did the *English* in *Pensylvania* and New Jersey get their cattle?" "Where did these *Swallows*

[1] According to Heckwelder, this site was called by the Indians *Kúequenâku*, which means the "grove of the long pine trees."

[Chimney Swifts] build their nests before the *Europeans* came and made houses with chimneys?" He had much to say about the more familiar birds[2] and beasts that he met with and heard of—their peculiarities and habits, and occasionally a grotesque story concerning some one of them. The weather, too, took up a large share of his attention, and he appears to have kept a careful record which is inserted as an appendix to the second volume of the translation.

Kalm constantly refers to his friend Dr. Linnæus, who evidently held the author of the "Travels" in high esteem. The generic name of our laurels—*Kalmia*—was bestowed by the great naturalist in honor of his humble friend, and Kalm, in speaking of the laurel, refers to this fact. John Bartram, the first American botanist, and whose house, built in 1731, is still standing, surrounded by its delightful old garden, was another to whom Kalm constantly refers in terms of friendship. His intercourse with Bartram and with Benjamin Franklin during his sojourn in Philadelphia was evidently a great source of satisfaction to Kalm, for he makes frequent allusion to his visits to and conversations with these worthies.

The "Travels" were not confined to the neighborhood of Philadelphia, though the author spent much of his time in this vicinity. He visited New York on one or two occasions, and made an arduous journey to Montreal, by way of the Hudson, and was at one time in some danger from an attack by the Iroquois. He seemed particularly struck with the French women of Montreal—their looks, dress, and good manners—and draws some rather invidious comparisons between them and their English sister residents. "In their knowledge of œconomy," he says, "they greatly surpass the *English* women in the plantations, who indeed have taken the liberty of throwing off the burthen of housekeeping upon their husbands, and sit in their chairs all day with folded arms." These remarks brought forth a defensive foot-note on the part of the English translator.

The "Travels into North America" is to be read in a spirit of simplicity, for in such a spirit it was conceived. One reads it as he reads "The Compleat Angler," or "The Natural History of Selborne," or Sir Thomas Browne—books that exhale a perennial fragrance, having their roots deep in the soil of things personal.

[2] See article by the writer in the *Auk*, Vol. XX., No. 3, July, 1903.

HUSAVIK.

SNOW MOUNTAINS ON SKJALFANDI.

A TRIP AROUND ICELAND

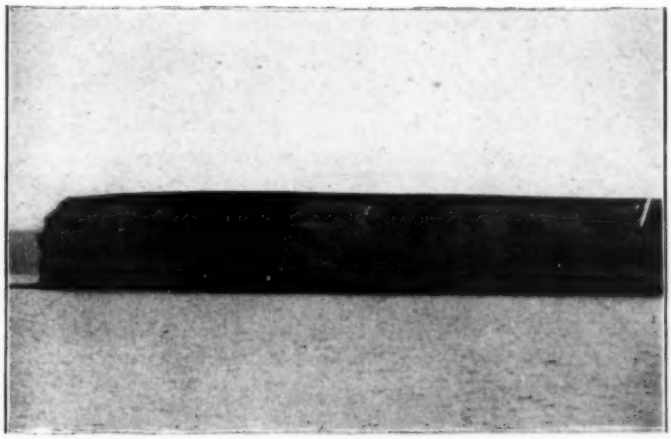
By L. P. GRATACAP

AMERICAN MUSEUM OF NATURAL HISTORY

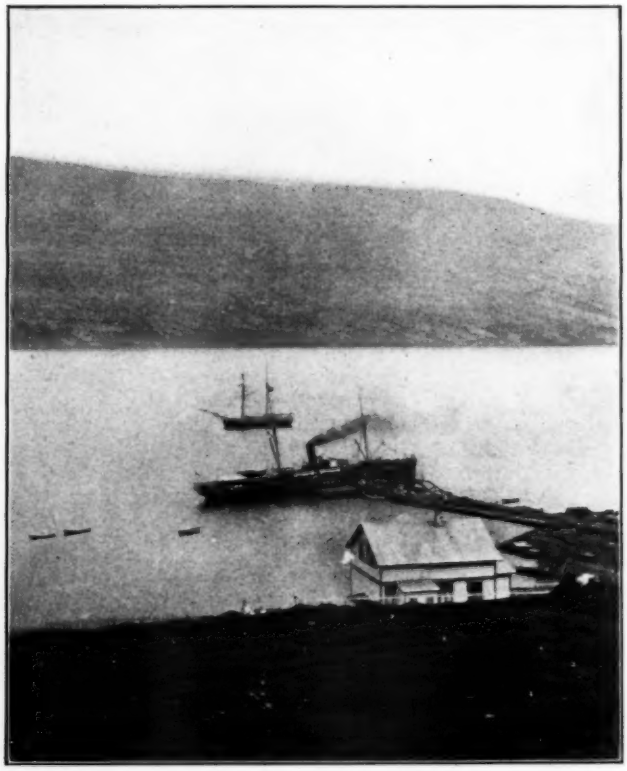
II

THEN came Husavik, a large village looking amazingly well with its extended domiciles cleanly cut in the sunlight, at the base of some old crater cone, which Professor Gourdon told us repeated the worn-down volcanic stocks of Auvergne, which that notable pioneer Guettard first pointed out were igneous accumulations. And how bare it all was! Two wild white swans suddenly swept through the foreground. We dropped off a *sysselman* here; a kind of local magistrate, governor, collector of the port, friend of the fatherless and widow, and general *Pooh-bah* who raised his hat as he left us as if he expected us to recognize his official importance. Icelanders pay the most formal respect to each other and doffing his hat for a person of a large acquaintance must, in so uncertain a climate, insure a popular man a permanent cold in his head. The *sysselman*, who thus returned to his domain, had an earnest mien, and was typical of the strong, resolute and intelligent temperament and mind of these boreal democrats.

We turned westward again over the *Skjalfandi*, the broad bay west of Husavik, toward the beautiful range of mountains on the opposite shore, the Viknafjöll hills. As they came near to hand in the transfiguring light of the setting sun, they were revealed as a series of enfilading peaks standing up behind each other, with the pockets between them spotted with snow, while snow-fields like spotless rugs hung low down on their steep flanks. They grew upon our eyes in



FLAT ISLAND NEAR HUSAVIK.

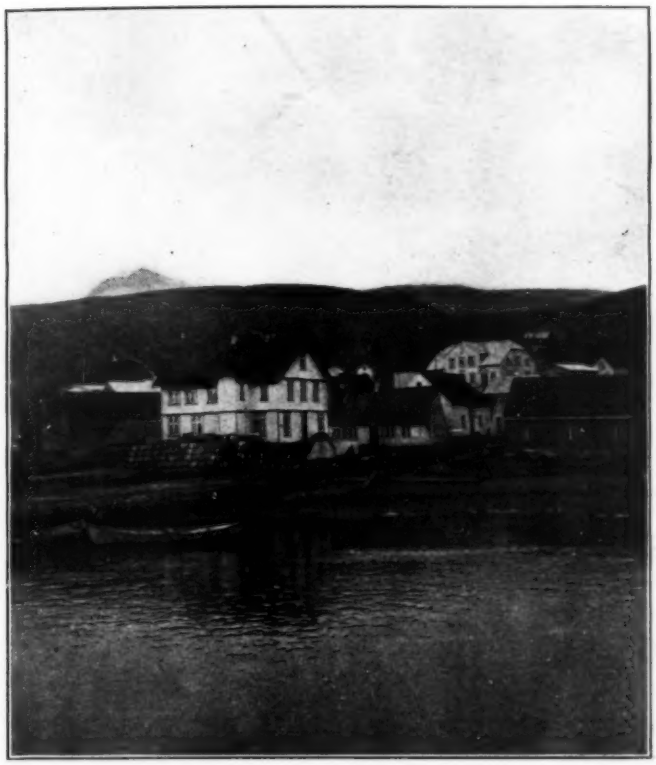


AKREYRI, DOCK FOR STEAMER.

magnificence and beauty, they seemed to exhale a spell in that northern latitude that drew us to them, pressed close upon the gunwales of our ship, in wondering silence.

The weathering, and subaerial erosion here was most pronounced—and the range seemed clearly older than the east-coast rocks. The sides of the mountains plunged with unhesitating precipitancy into the water. The beds composing them had variable inclinations. Still we drew nearer and closer—with wonderful displays of red rock disintegrating into rubble, and long sweeping and steep surfaces of comminuted stone. The higher cells, cirques or valleys in the mountains were floored with snow, and occasional glacial patches were uncertainly described. At a distance these mountains looked like a serrated range on a single base of extension, but nearer they were seen to be in ranks thrown up in most effective hummocky confusion.

And now a thousand lights play over them, and now they gleam with one consentaneous and single glory, like a pale and myriad facetted ruby. New features come into view on every side, at each new inclination of the ship; a rainbow stands upright piercing the zenith,



AKREYRI.

almost above them, and the sun floods the skies with pink and purple hues, painting also the low-lying bars of cloud with gold, to be itself slowly, slowly, quenched in a roseate ocean. And still the alpine glow bathed all the scene with opalescent reds, with violet colorings and russet lines, while the shadows of the higher peaks lay black upon the snows of the valleys below them. The picture remained perfect for an hour, its high lights shifting, but its beauty penetrating and immanent, spreading all over the solemn austere hills with changing marvelousness.

In the morning we found ourselves at the bottom of a fiord at the head of which we confronted an extensive marsh. This was Akreyri, a good-sized place, running around a curved shore with large frame houses, some three stories high, and a good road along the shore and up into the hills. About a quarter of a mile from the landing dock there is a deep *till* morainal deposit, packed with rounded pebbles, and prevalent evidence of an old beach line. Back of the shore on the village side rose sculptured snow mountains, and opposite across the fiord the long slant of a hill dissected by rill channels. This hill was the

ODDEYII.

usual wall or palisade of lava flows, with green grassed slopes at its foot.

The town, containing about 3,000 people, consists of sizable frame houses, some quite large. The public school is commodious, and there is a hospital and a hotel. The streets are named and the houses numbered. Here trailing along the roadsides and dotting the fields in color patches were the wild pansies (*Viola tricolor*).

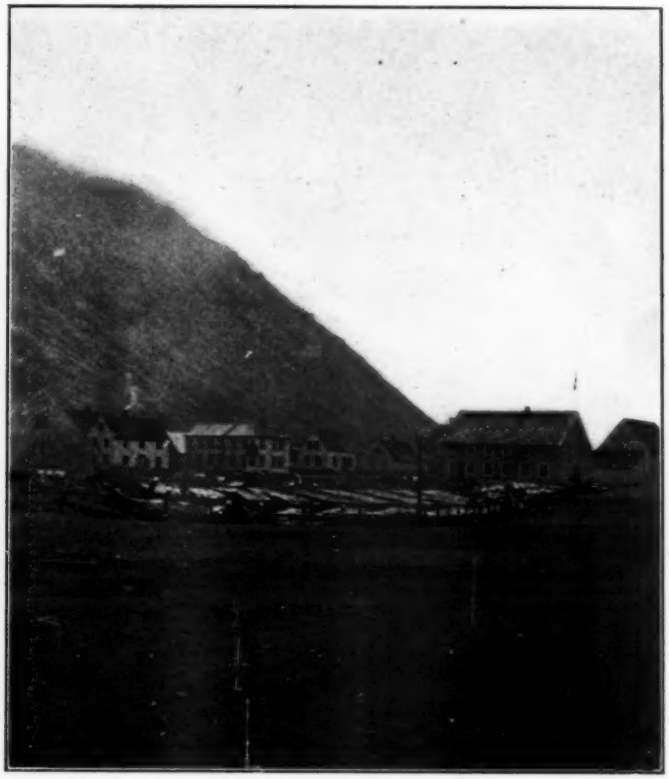
The next stop was in the Skagafiord at Saudarkrokr, where a remarkable raised beach suggested geological themes. If I was not mistaken in my notes on the conversation between a fisherman and the steward of our steamer, the fisherman was induced to furnish us with good herring at about a farthing a pound, which same fish sell for almost twelve cents a pound in Copenhagen. Fish were all about us and the herring nets, floated by buoys, seamed the water, with fishermen moving slowly to and fro gathering them in. The Icelander peasant fisherman is very poor, and, clad in rough clothes, with hairy bristling whiskers and worn eyes and shock hair, has sometimes quite an aboriginal appearance. He wears a sheep-skin slipper on his foot and heavy encasing woolen socks underneath leggings, and has no scruples about

RYKIAFIORD.

wading in the water as indifferently as if he wore Goodyear Rubber Company boots.

More geological themes stared us in the face at Blönduos where a glacial river discharges its mineral burdens into the sea in a turbid muddy tide. Again at Reykiarfiord we were called upon to esteem the endurance of the Icelander. The place is rough and stony, with a few houses and turf-covered cabins, an eider duck island or so, and wore an expression of depressing loneliness, albeit in the bright sunlight it bravely challenged our admiration. Again on our way with our former tireless companion—fog. In the weird night dawn, with the fog dissipated and the north cape passed, we pushed on to Isafjardarjup; and the high shores with dark menacing and austere contours loomed strangely over the fringed spray-scurried waves hissing around us. We plunged headlong into the inky billows until the cape headland gave us shelter, and the confusion about us subsided, and in the morning we woke in Isafiord—a thriving town on a crescentic spit of land enclosing a quiet lake-like harbor in which the *Vesta* floated.

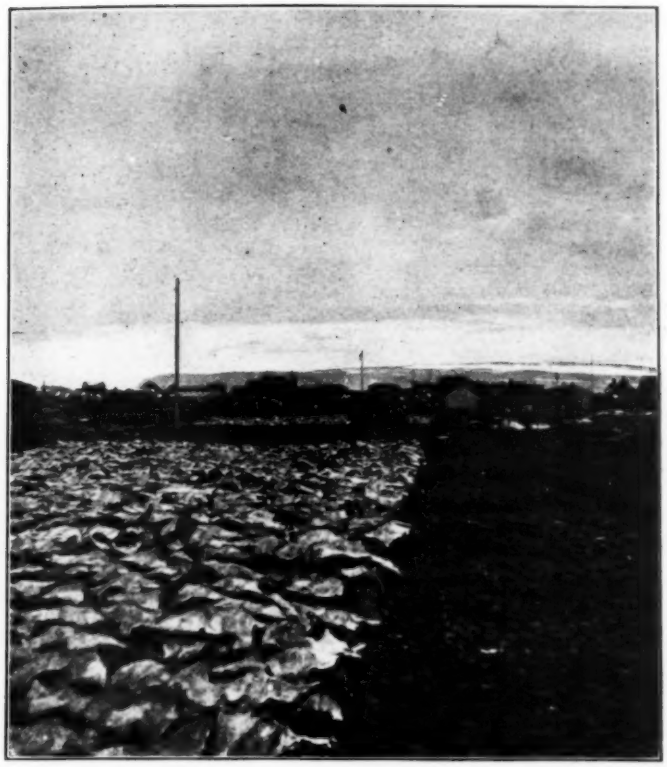
This fiord was the usual thing; walled in by high cliffs, plainly



COD FLAKES IN THE VILLAGE OF ISAFIORD.

banded by the successive flows of igneous rock, while at one point on the east wall an amphitheatrical cup was seen, just such as prevailed elsewhere, but here somewhat larger and accessible, and which begins the degradation and removal of the basaltic cliffs.

Early in the morning we left the steamer for the shore, and traversed the town. We saw the big cod storehouses where perhaps $10,000 worth of dried flat cod were piled up in snowy walls to the roof. Women work, spreading and weighing them, over the rocks. These women work eight or ten hours a day, and receive about fifty cents a day, the men about one dollar. The fish, headed and cleaned, of course, are gathered into flat piles over night, covered with oil skins, on which planks are placed, carrying a weight of stones, and distributed in the morning if the day is clear. There are perhaps three or four such establishments in the town, and they fill it with bustle and commercial activity. Stores (*Verzlun*), opened by German and Scotch traders, dispense to the people dry goods, art material, decorations and utensils, coffee houses entertain them, and, judging from the crowded

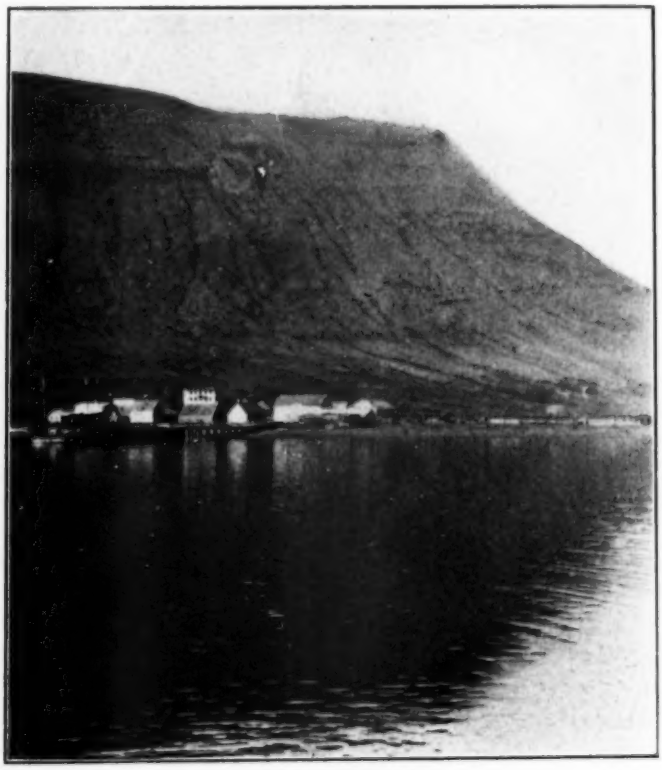


COD ON STONES, ISAFIORD.

post-office—to which our steamer had brought the letters—the outer world regularly reaches their doors.

I looked into the modest little church through its windows and discovered the altar with candles and a figure of the Christ. The religion of the island is Lutheran. The graves were marked in many instances by polished granite tombstones, many with Thorwaldsen's "Night," in a white medallion of porcelain, upon them, and all more or less covered with tin flowers and tin palms with linen flowers, in white, and many withered wreaths of bear-berries.

After breakfast I climbed up into the amphitheater on the palisades to the east, which in the shadows of the morning seemed remote and fascinating, with a great boulder of *liparite* flung upon its extremest lip like a propylon at the entrance of a temple. The views from this cup of erosion with its steep talus-slopes of comminuted stone—splinters and angular chips dislodged by frost, were superb—the outer fiord with its snow mountains with the water at their feet dyed *bleu foncée,* and the hill country southward with snow banks and threading



DYRIFIORD VILLAGE.

streams and Isafiord below me like a map. The outer entrance of the Isafjardarjup is magnificent and was seen about two o'clock in the morning, a bold, deeply fissured and mountainous coast.

Our next stop was Thingeyri, on the Dyrifiord, which was a small place in a rather deep fiord, the sides of the fiord displaying a series of radiating valleys divided from each other by eroded walls of rock, which presented sharp prow-like fronts on the fiord. The landscape here had a dusty, dry and barren expression with poverty of green surfaces, the rock gravelly and crumbling, and a hard strange loneliness enveloped everything. The long morainal wall at the mouth of the fiord has been dissected by elevation and the attacks of the sea, and continues the encircling chain of evidence around the shores of the island, of its elevation since glacial times, its emergence, which has brought in many places beds of marine shells into dry and exposed positions. To the south as we rolled again on the waters of the Denmark Strait, headland after headland succeeded each other down the coast with splendid sweeping beaches between. Then came a most remarkable long precipitous wall, like a creation of masonry, spattered

WEATHERED PALISADES IN DYRIFIORD.

fantastically with white splotches of guano, and celebrated as a home for the sea-birds, a veritable basaltic dike, eaten into by time and weathering, and furnishing innumerable nooks and ledges for the great population it harbored.

Desperate and vain efforts to get it to "go off" involved the captain and the engineer in savage denunciations of a small brass cannon, whose thunders were to awaken the sleeping (or dozing) inhabitants of this mural metropolis. When at last it sputtered its salute, a solitary bird rose jeeringly in the air, and the show was over.

Now we were crossing the Breitfiord (the broad fiord) a vast bay, sprinkled with stumps of rock in chains of islets, and darkening ominously under gathering wind-clouds, whose first puffs began to rumple and whiten the wide expanse. Then came a marine idyll, a little grass-covered island with rocky reefs and walls, and its upland quaintly decorated with a little village and small farm houses, whose roofs were white with flowering shepherd's purse and wild mustard, shooting up most naturally from the turf gables. The men and women were out harvesting the hay, and the pictorial charm of everything was

HOUSES AND SURF WALL AT FLATEY ISLAND, BREITFIORD.

increased by a slanting towered church very odd and lovely too, with its disheveled graveyard about it.

We crossed the bay to Stykkisholm, a picturesque village made up of snugly elbowing houses, crumpled together on a high rock, with black islets all about. It was ten o'clock P.M., and a yellow splendor filled the western sky, against whose wild light the sharply scissored outlines of the mountains ran in a black silhouette. The great arc-like boats came off in the morning from the shore, and were loaded, and their cargoes discharged on the dock, bands of women carrying the sacks on their backs, or taking the broad planks (for making furniture) between them.

We left Stykkisholm in the morning, which was cold and clear, and steamed out over the broad fiord with the snow mountains distantly gleaming and the lead-bottomed clouds in angry rolls pouring over them to the south. Towards three in the afternoon we reached the crater-peak of Snaefells, with its glacier or jokull, which terminates the long peninsula between the Breitfiord and the Faxafiord. At first Snaefells was clouded and capped with mists. Then we saw a long

LITTLE CHURCH ON FLATEY ISLAND, BREITFIORD.

flat flow of trap on the coast, spattered, like the bird-rock we had passed, with guano, and riddled with caves and excavations, and following that, we approached the shore at the base of the magnificent mountain. It was a beautiful picture, its expanded base rising into a dome on which spread the ice and snow cap-like flat helmet, surmounted by two monticules or mammillary peaks, one darkened by an enclosed rock. The view of the mountain improved each minute, until at last its glorious argent dome was swept clear of clouds, and in the lucid brilliant air shone like a silver shield. The physical aspects of the mountain below the snow fields were most interesting. The guttered flanks, deeply channeled with a network of *rainures*, whose interlaced troughs resembled the crossing and interference of paths of flowing material, but was interpreted by Professor Gourdon as purely erosive, were highly instructive. The spectacle the mountain made was undoubtedly very fine, and for the whole afternoon, until actual semi-night and knotted clouds hid it from sight, it remained the majestic crown to the broad panorama of snow mountains stretching eastward. We were now in the Faxafiord.

STYKKISHOLM.

And then came Reykjavik, of which and the *interior* of Iceland the editor may permit me to say something at another time.

NOTES ON THE DEVELOPMENT OF TELEPHONE SERVICE

BY FRED DELAND
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XVI. THE HARD TIMES OF 1885

THE year 1885 will never be forgotten by the "hard times" sufferers—nor by many operating telephone companies. For commercial and industrial conditions rapidly slid down to bedrock, and thousands who were thrown out of employment suffered for the bare necessities of life. Some of the local telephone companies had a fair income, but nearly all had to defend at heavy cost, a series of systematic attacks upon the rates charged for local service. In 1885 the bank clearances were over fifteen billions of dollars less than in 1883, the production of pig iron was lessened by nearly 600,000 tons, while its price fell to $18 a ton from $22 a ton in 1883. So great a commercial and industrial depression naturally affected the financial growth of the parent Bell company; and then, that its bitter cup might be full to overflowing, all the power of the United States government was brought to bear on the fundamental Bell patent, in the hope that it might be invalidated. Referring to this most unjust and discreditable attempt to lend the dignity and the power of the United States to a deliberate scheme to filch honors justly awarded, the editor of *The Nation* wrote that this

> decision to have the validity of the Bell telephone patent tested in the courts . . . insures the success of one of the worst stock-jobbing schemes now before the public. The stock in trade of the companies on whose motion the suit is brought consists of a paper capital of several millions, and a few patents of insignificant value which they probably never intended to use.

In July commercial conditions in the east experienced a brief boom, brought about by the absorption of the costly West Shore line by the New York Central interests. But the farming community had invested heavily in West Shore, and following the reaction due to heavy losses distributed among a large number of grangers came increased distrust not only in railway, but in all industrial securities, including even those of the best local Bell companies.

However, the farmers were enriched by the greatest crop of corn ever grown up to that year, exceeding by one hundred and forty million bushels the bumper crop of the previous year, while the yield of cotton secured by planters in the south was nearly as large as the summer before. But the farmers harvested one hundred and fifty-five million

bushels less of wheat than in 1884, and a bushel of wheat was worth nearly two bushels of corn, wheat selling at an average export price of 87 cents and corn at 49 cents per bushel. On the Chicago market wheat ranged from 73⅜ cents to 91¾ cents per bushel. During the fiscal year beginning July 1, 1885, there was exported only 57,759,209 bushels of wheat having an aggregate value of $50,262,715, as against 106,385,828 bushels in 1882 having an aggregate value of $119,879,341.

Each month brought reports of the large number of telephones taken out at the request of subscribers; yet, when the returns for the year were tabulated, the totals for all the Bell companies in the United States showed a net gain in subscribers of 2,903. Owing to the extreme financial depression this was an entirely unexpected increase.

One company, in reporting a gain for the year of nineteen stations, expressed its elation over the fact that it meant a net gain of thirty paying stations through the elimination of a number of deadheads. This company reported having "removed 1,147 instruments and placed 1,179," during 1885, and added:

When we analyze the places in which we gain and lose, we find that of the fourteen exchanges containing over one hundred subscribers, which we are working to-day, all but three are larger than they were a year ago, while of the nineteen exchanges of less than one hundred, all but six are smaller than they were in April, 1884.

This company was operating thirty-three exchanges with an average of 171 subscribers to each exchange, and was in a stronger financial condition than three fourths of the other companies. Yet its treasury stock was unsalable at any reasonable price, even though the purchaser knew that the entire proceeds of the sale would be devoted to new construction. Two and three years previously people went wild over telephone stocks, not only borrowing money from banks to use in purchasing telephone securities, but actually mortgaging homes. But during 1885, it was only possible to dispose of many local telephone stocks by allowing an enormous discount of from 50 to 80 per cent. from par value. So this company told its stockholders that

we are convinced that we are now at the period when we must look to our current earnings to pay for all expenditures of every kind whatsoever. The system, as now established, must not only maintain itself, but must provide for the ordinary extensions and improvements which the growth of population and business and the development of improved apparatus may demand.

Notwithstanding the several concessions granted its licensees by the parent company during the previous year, it perceived early in 1885, that the prevailing industrial conditions coupled with the low financial condition of a majority of the local companies, rendered necessary a further modification in relationship. During 1884 the parent company returned $806,634 to the operating companies in which it held shares of stock, which was its proportion of the net earnings,

that this amount might be spent for necessary improvements and extensions on the part of the local companies.

Following many of the numerous consolidations, the parent company granted to the consolidated companies a perpetual license covering the exclusive use of Bell equipment in specified territory, in exchange for the short-term licenses that had expired or were about to expire. In return for these perpetual exclusive rights the local companies issued to the parent company from 20 to 33 per cent. of the capital stock of the new organizations. Thus parent and operating companies became joint partners having every reason to protect each other's interests, even after the expiration of the fundamental patents.

Owing to the stress of financial conditions, early in 1885, the parent company decided to call a conference of the operating companies to ascertain what mutual action was advisable, in order to restore confidence among the shareholders of the consolidated companies, as well as to awaken an interest in telephone securities on the part of prospective purchasers. With that end in view it invited all local companies to send one or more representatives to a meeting to be held in Boston, June 8 to 13.

During the sessions of this conference all phases of relationship were broadly discussed and many perplexing problems thoroughly threshed out, several important concessions were made, and a further reduction in royalties announced. At the closing session the delegates tendered to the parent company a vote of thanks

for the substantial benefits resulting from the conference and its disposition to strengthen our hands in developing the business; (and assured) a continuance of our hearty support and cooperation, with renewed vigor and confidence.

In its annual report for 1885, the parent company referred to the results of this conference as follows:

With longer experience the telephone companies have learned that the cost of maintaining and reconstructing their plant has been generally underestimated, and many of them have in consequence been forced to recognize that the profits upon telephone business are less than they had expected and believed. For this reason they have appealed to us to make certain concessions in their contract relations, and we have given this subject careful consideration. . . . We have met our licensees; *first*, by agreeing when desired, that our share of net earnings, jointly with theirs, may be used for construction purposes, so that we in these cases are sharing the cost of developing the business; *second*, we have made a reduction in the royalties on telephones used in small places where the rates are low. This reduction involves a loss of royalty amounting to about $200,000 per annum on our present business.

While comparisons are rarely pleasant to present, yet it is interesting to compare this voluntary action on the part of the Bell company, with the resolutions passed by the licensees of another parent public utility company. This latter parent company was not in the telephone business, but it made arrangements

by which these local companies had the exclusive and absolute right to the sale of apparatus in their respective territories. In return for this they gave to the company a certain percentage of their capital stock, not for one year or two

years, or any fixed length of time, but perpetually and upon any increase of capital stock. These licensees, however, were not guaranteed by the parent company against infringers of the patents, or given protection in any way equal at the time to the rights which they sacrificed. The makers of other apparatus which infringed the patent came into their territory unmolested and sold in competition with them. The result is that during the past ten years the licensees have not secured any considerable portion of the profits which justly belong to them. In return for the stock which they surrendered the local companies were to secure a special rate upon apparatus, which would enable them to compete successfully with any rivals. As a matter of fact this privilege was never secured and the apparatus of other manufacturers could be obtained upon the market at a price which was actually less than that which they had to pay to the parent company.

During the year 1885 systematic attacks upon the rates charged by operating Bell companies were started in several states, notably in Massachusetts and in Indiana. In Massachusetts the movement began the previous year, and is said to have been instigated by and supported almost entirely through the efforts of one man who felt that he had not been fairly treated by his associates when the local company in which he was a shareholder had been absorbed in a general consolidation. The method this man adopted was to employ boys in different cities to rapidly circulate petitions in favor of reducing telephone rates in the respective localities. Naturally, not only friends and acquaintances of the boys, but thousands of other persons signed the petitions to help the lads earn the promised pennies. In this manner a total of about 50,000 signatures were secured. When these petitions were presented to the legislature, it was shown that nearly three fourths of the signers were not subscribers to telephone service, that a number of names had been placed on the petitions without authority, and that many of the alleged petitioners could not be located. For instance, ninety signatures were secured in Lynn, and only four of the entire number represented telephone subscribers. Of the eighty-six non-subscribrs, the names of twenty-seven did not appear in the city directory, nor could the individuals be found. Then it was publicly charged that this lot of petitions had been shown to the Bell interests and offered to them for $12,000 in cash. It was further stated that

as no purchaser could be found, the whole batch of petitions finally found their way to the legislature, which, in its final judgment, placed the same value upon them as the directors of the Bell company had previously done.

On April 13, 1885, the Indiana legislature passed a drastic law that later was repealed:

that no individual, company or corporation now or hereafter owning, controlling or operating any telephone line in operation in this State shall be allowed to charge, collect or receive as rental for the use of such telephones a sum exceeding three dollars per month where one telephone only is rented by one individual, company or corporation. Where two or more telephones are rented by the same individual, company or corporation, the rental per month for each telephone so rented shall not exceed two dollars and fifty cents per month.

When this law went into effect, six different companies or individuals were operating telephone exchanges in Indiana under Bell licenses,

and as this bill threatened to largely reduce their prospective incomes, it required wise planning to keep the outgo within the estimated income in order to avoid bankruptcy. The first step taken was to suspend night service in some places. In turn the citizens, the great majority of whom had never patronized the telephone company, exhibited an utter disregard for the rights of others by cutting down the telephone poles. A large number of exchanges and over one hundred toll stations in Indiana were closed, and all improvements and extensions ceased.

Fortunately for all concerned, there was a golden lining to the dark cloud that overhung the telephone field in 1885, in this that no less than six important decisions were rendered in favor of Bell interests. Five of these were judicial, being handed down in the United States circuit courts in the respective districts, and one was the important decision rendered by Commissioner Butterworth of the Patent Office.

It may be recalled that on October 23, 1884, the examiners-in-chief in the United States Patent Office, after a very thorough and complete investigation of certain interference claims involving the invention of the telephone, and after each claimant had had his rights fully presented in lengthy arguments, decided that

Bell is the only one of the contestants having patents. Bell is not only a patentee, but it is to him that the world owes the possession of the speaking telephone.

Earlier in 1884 the examiner of interferences had rendered a similar decision, after eighteen months of thorough investigation. This decision was exceedingly elaborate, making a printed volume of over three hundred pages, and reviewing the law and the evidence, including every fact and phase with great care. From this decision the claimants appealed to the examiners-in-chief, as stated, and from their decision to the commissioner of patents. After a seven days hearing the commissioner decided that

Bell discovered, and his patent showed that a certain combination of magnet, diaphragm and armature, when arranged in a specified connection with other specified parts, constituted an apparatus which would transmit articulate speech. Up to this time no one else had done this, or had known it. The combination was the result of his conception and the outgrowth of his theory, and the apparatus, being a materialization of that conception and in conformity to that theory, was his original invention.

In January, 1885, Judge Butler, in the United States Circuit Court, District of Pennsylvania, in granting the motion of the parent Bell company for an injunction, decided that

upon full and patient examination of everything submitted to us, we believe that the alleged new matter is but the refuse and dregs of the former cases—if I might be allowed the use of so homely an illustration, I would say, but the heel taps found in the glasses at the end of the frolic.

In March, 1885, Judge Wallace, in the United States Circuit Court, Northern District of New York, in granting the request for an injunc-

tion against an infringing company, stated that

this is a case in which an injunction must issue, beyond any sort of doubt. The questions upon the merits, for the purpose of preliminary injunction, have been already disposed of in the Pennsylvania and New Jersey cases,

In June, 1885, Judge Wallace, in deciding that the Molecular Company had infringed "all the claims" of the Bell patent, stated:

After Bell has pointed out the way, it may now be seen to be a simple thing to introduce his method into the Reis apparatus. Some of the experts have doubtless convinced themselves that these modifications of the Reis apparatus do not involve any difference in the principle of the apparatus. It is too late to accept this theory after the lapse of so many years of fruitless experiment with the method of Reis, as originally suggested by Bourseul, and with the apparatus of Reis, as modified by various experimentalists down to the time of the promulgation of Bell's method. It seems impossible to escape the conviction that had the speaking telephone been left where it was left by Reis, and by those who endeavored to develop and perfect his theory, it would only have realized the speculations of Bourseul.

In July, 1885, Judges McKennan and Acheson, in the Circuit Court of the United States, Western District of Pennsylvania, in allowing an injunction stated

that while this country has been agitated for several years past by litigation about this Bell telephone, and while there were decisions in the courts, at any rate in Massachusetts and in New York, and in this circuit, these defendants, with the knowledge of all these decisions, have entered upon a course of infringement of the rights of these complainants, that have been passed upon by the courts. . . . If these people, believing that they had a right to do it, without any decision of the Court, and without any notice whatever from the party whose rights they sought to appropriate, had commenced this business, it might be said with some sort of claim of equity, that they had been misled, and that therefore, they ought not to be stopped by an injunction where such injunctions would subject them to loss which they did not expect. That is not the case here as I have said several times. They have invited this controversy. They have stood up and said to Bell, "You are not the inventor of this thing, and we are going on in defiance of the patent which has been granted by the Government, and in defiance of the decisions of the Courts sustaining it." Now, that is just the aspect of the case, and I know of no rule by which the Court has heretofore been governed in the disposition of motions of this kind, which would justify us, for one moment, in treating these defendants with special favor, even independent of the decisions of the Circuit Courts. The injunction is allowed.

In December, 1885, Judge Wallace said:

Since the decision of this case in December last, additional proofs have been taken on the part of the defendants (The People's Telephone Co.) and by consent of complainants, have been presented for the further consideration of the Court after argument of counsel. All the new evidence is cumulative merely. Such as consists of the testimony of new witnesses to knowledge of the existence of Drawbaugh's talking machine prior to the date of the Bell patent, is far less persuasive than much which has already been considered and rejected as incredible. . . . The legitimate effect of the evidence is to show that Drawbaugh was very near the realization of the invention, if he had really constructed instruments like the exhibits *F*, *B* and *C*, prior to the date of Bell's patent. It does not, however, alter the fact that he was unable to make such instruments at a period long subsequent to the time when he claims to have made them; and in view of this fact the evidence does not tend to materially fortify the testimony of the witnesses, who think, or profess to think, that they heard, or saw efficient practical instruments in operation at Drawbaugh's shop on the occasions to which they refer. The conclusions which were reached at the former hearing have not been modified and the decree ordered should not be disturbed.

THE INSTITUTE OF FRANCE, AND SOME LEARNED SOCIETIES OF PARIS[1]

By EDWARD F. WILLIAMS
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I

THE Institute of France has been called the greatest educational work any government has ever organized and supported. Be that as it may, there is no denying that the service it has rendered learning and literature, scientific research and the fine arts, has been extensive and stimulating, that, beginning with the organization of the French Academy in the time of Richelieu, its history covers in a good degree the history of the intellectual and social development of the French people.

The institute embraces in its present organization five academies which in the order of their establishment, if not in importance, are as follows: The French Academy, to which the forty immortals belong, the Academy of Inscriptions and Belles-lettres, the Academy of Sciences, the Academy of Fine Arts, the Academy of Moral and Political Science. The academies existing at the time of the revolution were abolished by the Convention as aristocratic in their tendency, and some of their members, known or supposed to be in favor of the monarchy, were guillotined, but as it was soon discovered that the knowledge of the members of the Academy of Sciences could be made of use to the new government, they were appointed on the commission of weights and measures. Thus some of the members of the old organization, meeting occasionally for the discussion of scientific subjects, managed to preserve at least the semblance of an academy of science. The so-called National Institute of Science and the Arts was recognized by the Directory August 22, 1795, and divided into three classes: (1) physical science and mathematics, (2) moral and political science, (3) literature and fine arts. From about 1667 to 1806 the sessions of the academies were held in the Louvre, in the great hall of Henry II. Since that time they have been held in a building which belongs to the institute, the Mazarin Palace, which was built by Cardinal Mazarin for the College of the Four Nations during the years 1661–5. It contains his library of more than 100,000 volumes, which is cared for

[1] Authorities: Maury, 'History of the Old Academy of Science'; reports of the academy from year to year; statements in Minerva from its foundation; 'History of Paris Educational Institutions,' by Alexandre De Maistre.

by a member of the institute. The institute has its own library also, equally large and embracing nearly all the books which are of interest to its members. The five academies are thus housed under one roof and on different days occupy for their gatherings the same rooms. To the public only the halls are open in which the annual meetings or receptions are held, though far more important for the members of the institute are the laboratories, or the rooms in which they do their work. While each academy is independent, there is yet a government common to the five academies in addition to the supervision exercised over them by the minister of public instruction. The institute has had no political power, and care has been taken to reduce its possible political influence to the lowest terms. So great was the fear of this influence that parliament in the time of Richelieu hesitated for more than two years before granting the original academy a charter. It was this same fear which led the convention to abolish the academies altogether. The history of the last hundred years shows how groundless these fears were, and how wise it is to favor organizations of learned men for the cultivation of whatever fields of literature or science they choose to enter.

The institute was reorganized by Napoleon in 1803 as the Imperial Institute of France, and divided into four classes: (1) Mathematics and natural science, (2) French language and literature, (3) classical languages and literature, (4) fine arts. After the restoration in 1816 the institute was again reorganized as the Institute of France and to it in 1832 a fifth academy was added, that of moral and political science. Each of these academies, or classes, elects its own members, subject to the approval of the government, but are all controlled by a committee representing each one of them.

The French Academy

The oldest of these academies (l'Académie française), the French Academy, was founded by Cardinal Richelieu in 1634. It received at Richelieu's request letters of recognition from Louis XIII. in January, 1635, but was not recognized by parliament till July 10, 1637. As early as 1630 a number of literary men had met at each others houses to discuss subjects of a literary nature and to encourage each other in efforts to improve the language and literature of the nation. Richelieu, then prime minister, determined to give the association his favor and to bring it into connection with the government. As a government institution he believed it would reflect credit upon the reign of the sovereign. For a few years the meetings were held in the Royal Library. Its purpose was declared to be, to improve the French language, criticize literary works and make a dictionary. Richelieu was anxious that it should publish a grammar also, a rhetoric, and an

authoritative treatise on poetry, but for some reason his wish has not yet been realized.

Membership in the academy was made difficult from the first. A few men, Boisrobert, Conrart, Chapelaine, Rotrau and Corneille were enrolled as a matter of course, as charter members. But only the most eminent literary men were to wear its honors. Two years after its recognition by parliament the number of its members was fixed at forty, and this number has remained unchanged till now. The privilege of being one of the forty must be sought for, and the person desiring election must personally visit each one of the members and solicit his vote. In the case of Buffon, Thiers and Béranger the rule was set aside, but as Béranger declined the offered honor, the rule of personal solicitation has become more rigid than ever.

The reception of a new member is public and is a great occasion. The new member is expected to eulogize the man whose place he has been chosen to fill, and to give in writing an estimate of the value of his works. To his thanks for the honor he has received through his reception into the academy the president responds in a few fitting words. The public, sometimes dissatisfied with the action of the academy, has created a *forty-first chair,* into which it puts the man who has been overlooked or neglected. In this chair it has seated Descartes, Pascal, Molière, Rousseau, Diderot, Dumas père, Balzac, Alphonse Daudet, Emile Zola. In 1778 the bust of Molière was set up in the hall with the inscription:

Rien ne manque à sa gloire, il manquait à la nôtre.

Though by no means a bureau of lexicography, its chief work, outside of criticism, has been the making of a dictionary of which the first edition, after fifty-nine years of labor, appeared in 1694, the eighth in 1896. Colbert when prime minister is reported to have been very impatient over the progress the dictionary was making, and one day, quite unexpectedly, came upon the academicians when at their work. Listening for a time to the definitions proposed for a very simple word, to the discussions which followed, and perceiving the difficulties in securing a definition at once comprehensive and accurate, he concluded that the task in hand would require far more time than he had thought, and was indeed a far more difficult task than he had supposed. From this time on he ceased his criticisms. The academy is now planning and at work on a historical dictionary of the language, on a scale so large that a wag has said it will take at least a thousand years to complete it, but he adds, as it is made up of *immortals,* the element of time need not be considered.

The academy expends more than 100,000 francs a year ($20,000) in prizes. These are granted for the best work in poetry, history or

moral philosophy which has appeared during the year, and also for the best oration or essay. The Montyon prizes, worth 22,463 francs, are for the best work of any sort by a Frenchman produced during the preceding twelve months. A prize, worth 21,940 francs, is for the best work on the application of knowledge to the arts. The Gobert prizes are for the best history of France, or on some point connected with its history. A special prize is offered every year for the best poem or essay upon a subject which the academy itself suggests.

The government pays each of the members of the academy the sum of 1,200 francs a year as a pension. The same sum is given to the members of the other academies which belong to the institute. The secretaries of the different academies receive 6,000 francs annually. Special grants are made from time to time for special objects. Thus in 1902, 10,300 francs were voted for the dictionary and other publications, 4,000 francs for a special prize, and 13,900 francs for miscellaneous uses. Sessions are private, save at the reception of a new member, the annual meeting in November, and the gathering of all the academies on October 25, when the large hall is crowded to suffocation.

It is impossible to estimate the influence which this academy has exerted on the literary life and taste of the French people. Nor can one determine the value of its contributions to the development and purification of the French language. There can be no doubt of its usefulness, or that in its work it has more than realized the hopes of its founders. Its influence at present is hardly less powerful than in the earlier years of its life. In fact, it may be truthfully said that in its unique character and position it has long been, and still is, the wonder and despair of other nations.

The Academy of Inscriptions and Belles-lettres

This academy, the 'little academy,' as it was nicknamed, the second in the order of formation, was established under the ministry of Colbert in 1665. At first it was simply a committee of four persons chosen from the French academy to work on inscriptions, form devices or emblems, suggest medals representing important and striking facts in the national history and furnish designs for the royal tapestry. It did not receive its name or enter upon its definite field of labor till 1701. Prior to this time its members, whose number had been gradually increased, discussed antiquarian and archeological subjects, and in this direction did good work. It was in the year 1701 that the Abbé Bignon asked the king to recognize it as an academy, give it a name and determine its duties.

Although the request of the abbé was received favorably, the new academy did not receive its charter till the time of Ponchartrain, July 16, 1706. Its name or title was not given till 1716. Then, as now, it

had forty working members resident in Paris. There were ten associate or free members, in training for vacancies in the active membership. There were eight foreign associate members and fifty corresponding members. This academy was suppressed by the Convention in 1793 and did not reopen under the Directory in 1795.

It was reconstructed by Napoleon in 1803 under the title of 1716, and its old field, the study of language, assigned to it. It now gives, through carefully selected committees, special attention to the study of Greek and Roman antiquities, as well as to those connected with French history, to Assyriology, Egyptology, epigraphy and the literary history of France. It looks after the French schools in Rome and Athens, which under its guidance have made important antiquarian researches and discoveries in Greece, the Grecian islands, Italy, Asia Minor, North Africa and Syria. Its Mémoires are full of extremely valuable information. Its activity along its various lines of study and research is unabated, and the means for the enlargement of its work, in addition to government support, are constantly increasing.

It grants several prizes, but no one of them is so highly esteemed and so eagerly sought for as the one which secures its holder two years' residence and study in Rome and Athens. The prize is won in a severe examination and against many competitors. It was through the influence of members of the school at Athens, and under their personal direction, that the temple at Delphi was uncovered, and that many other interesting remains of Grecian antiquity have been brought to light. To no one of the academies connected with the institute are students of history, the classics, antiquities of every sort and oriental languages, more deeply indebted than to the academy of inscriptions. Some of its members have been among the leading scholars of the nineteenth century. Its standard of work is very high, as one who will read the jubilee history of the school in Athens will discover. Nor is its work of less interest or importance to-day than it has been in the past. While granting prizes every year there is one prize, the Louis Fould, worth 20,000 francs, which prior to 1896 had never been awarded. It is offered once in three years for a satisfactory history of the arts of design, their origin and progress, and their transmission through different peoples to the time of Pericles. The subject is so difficult and the scholarship required so extensive and accurate that few can hope to win it.

The Academy of Sciences

The Academy of Sciences, regarded by scientific men as the most important part of the institute, and whose history will be related more fully in other articles, was founded by Minister Colbert in 1666. It grew out of informal gatherings of scientific men who met from time

to time to discuss reported discoveries in the scientific world and to suggest and criticize theories of their own. It is the largest of all the academies connected with the institute, having sixty-eight members, two secretaries, ten free members in training for vacancies in the active membership, ten honorary members residing in France, eight foreign associates and one hundred corresponding members. It receives an annual grant of 64,000 francs for publications and has a large amount of money at its disposal for prizes. The work of the academy, which is very extensive and which aims to cover the whole scientific field, is done through committees. In the mathematical section of the academy there are committees for geometry, mechanics, astronomy, geography and ship building. In the section devoted to physics there are committees for chemistry, mineralogy, botany, rural economy, anatomy, zoology, medicine and surgery. The sessions are on Mondays at 3 P.M., although the members of the academy are in their laboratories every day in the week with the exception of Sunday. Its work in science has perhaps been more brilliant and extensive than that of any other scientific academy in the world. It offers an annual prize of 3,000 francs for the best discussion which has appeared during the year on a mathematical topic or on one in physics. It has six Montyon prizes at its disposal, worth in all 44,845 francs. The valuable Laland prize for astronomical work is under its control. Its annual meeting is in December. Its Mémoires are of the greatest value, and are highly prized by scientific students the world over. From property made over to it by the Duc d'Aumale in 1886, at Chantilly, it is thought an income of at least 550,000 francs each year will be received. This income is not yet fully available.

The Academy of Fine Arts

The Academy of Fine Arts, though existing under this name only since 1795, was really founded by Mazarin in 1648 as an academy of painting. Sculpture was made one of its departments in 1664, music another in 1668, architecture another in 1671. In 1815 this academy was fourth in order of importance in the institute and in order of organization. At that time some of the first men in France were members of it. Its chief interest is, and has been, in and for the fine arts. In this department of study it has been preeminent. Although its publication fund has been only 6,000 francs a year, it has brought out many valuable works, among them a dictionary of the fine arts. It has forty members, ten associate members in training for the vacancies which may occur, ten foreign associate and sixty-one corresponding members. Its annual meeting is one of the great social events of the year. It takes place in October. Women are always present in large numbers. While the addresses are interesting, the chief attractions are

in the distributing of the prizes, which consist of a medal and a diploma which entitle the possessor to a two years' residence in Rome. These prizes are granted for excellence in painting, sculpture, architecture and musical composition. Its meetings, like those of the Academy of the Immortals, are in private, while those of the other academies, though attended by but few, are open to the public.

The Academy of Moral and Political Science

The Academy of Moral and Political Science was the creation of the revolution. By its originators it was made the fourth in the institute. Suppressed by Napoleon in 1803, it was reestablished in 1832 at the suggestion of Guizot, then prime minister. It began with thirty members, but in 1855 the number was increased to forty, with ten free members in training for the vacancies, forty-five corresponding members and six foreign associate members. The academy does its work through five groups of men who form committees on philosophy, morals, legislation, public law and jurisprudence, political science and statistics, general and philosophical history. Its sessions are on Saturdays at 1 P.M. The academy has always been an object of dread to revolutionists, and to men like the first Napoleon, but of special interest to lovers of freedom and progress. Some of the most distinguished names in French history are on its books, names of men like Bartholomew St. Hilaire, who was an active member more than fifty years, Guizot, Louis Reybard, Jules Simon, Cousin, Geraud, Hippolyte Passy, Michelet and scores of others almost as eminent.

Other Learned Societies

But the institute, far-reaching as have been its aims, has by no means met all the needs of the learned men of Paris or prevented them from forming self-supporting societies in large numbers for special work in various fields of research. It has, in fact, stimulated the formation of these societies. The names of some of the more important of these societies follow:

The Academy of Medicine, formed by royal command December 10, 1820, has a constitution like that of the Academy of Sciences and a large membership. Its meetings are on Wednesdays during the working portion of the year.

The French Association for the Advancement of Science, now united with the Scientific Association of France, was founded by Le Verrier in 1864 and has at least 3,400 members, each one of whom pays as dues 20 francs a year.

The National Acclimatizing Society of France, zoology and botany applied, founded in 1854, has a membership of 1,000. The dues are 25 francs a year.

The Astronomical Society, founded 1803, has 500 members. Its dues for Frenchmen are 9 francs, for foreigners 12 francs.

The Anthropological Society: founded 1859; 500 members; dues 30 francs.

The National Society of French Antiquarians: founded 1805. Till 1813 The Celtic Academy.

The Asiatic Society: founded 1822; 250 members; dues 50 francs.

The Biological Society: formed 1848; 40 members, 22 associate and 15 corresponding members; dues for active members 20 francs, for associate 15 francs.

The Botanical Society of France: formed 1854; 360 members; dues 30 francs.

The Society of the National School of Maps: formed 1839; 346 members; dues 10 francs.

The Chemical Society: formed 1857; 1,500 members; dues for Frenchmen 36 francs; foreigners 25 francs.

The National Society of Surgery: formed 1843; 35 members; dues 60 francs. This society is formed of the most eminent surgeons, and is therefore limited in its membership.

The International Society of Electricians: formed 1883; 1,270 members; dues 20 francs.

The Entomological Society of France: formed 1832; 490 members; dues 25 francs.

The Geographical Society: formed 1821; 2,078 members; dues 36 francs.

The Geological Society of France: formed 1830; 30 members.

The Association for the Encouragement of Grecian Studies in France: formed 1867.

The Society of French History: formed 1833; 600 members; dues 30 francs.

The Society of Diplomatic History: formed 1886; 600 members; dues 20 francs.

The Paris Society of Linguistics: formed 1864; 228 members; dues 20 francs.

The Mathematical Society of France: formed 1872: 280 members; dues 20 francs.

The Paris Society of Medicine: formed 1796; 70 regular members; 15 honorary; associates unlimited; dues for regular members 30 francs.

The Meteorological Society of France: formed 1852; 145 members; dues 10 francs.

The French Society of Mineralogy: formed 1878: 200 members; dues 20 francs.

The French Society for Numismatics: formed 1865; 200 members; dues 30 francs; receives associate members whose dues are only 20 francs.

The French Society for Physics: formed 1873; entrance fee 10 francs; dues 20 francs, half as much for non-resident members.

The Society of Ancient French Texts: formed 1875; 350 members; entrance fee 10 francs; dues 25 francs.

The Zoological Society of France: formed 1876; 350 members; dues 20 francs.

Societies for the study of electricity, architecture, political and social science are filling an important place in the higher life of the city.

Observing the dates of the formation of these societies, one will perceive that nearly all of them came into existence during the nineteenth century, most of them in the first half of the century. By these dates one can trace with a good degree of accuracy the progress of science, and especially of that branch of science which each society represents. Other societies will of course be formed as the *call* for them *arises*. In many respects better work is done in these independent bodies than in the academies connected with the institute, which in part at least are under the control of the government, and in which membership is limited to those who have already won fame.

RECENT VIEWS AS TO THE ORIGIN OF THE GREEK TEMPLE

By Dr. ALEXANDER F. CHAMBERLAIN

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GREEK genius was brought a little nearer that of the commonalty of mankind, some years ago, by the discovery that marble statues were painted red in imitation of the wooden human figures long after marble had come into use as a material for sculpture. It now seems as if the Greek temple was to be recognized as the imitation of something previously existing, and that once again the "gulf" over which the Greek mind is supposed to have suddenly leaped has been reduced to quite ordinary human dimensions. It has long been customary to look upon the Greek temple as absolutely unique; the Doric temple, even if it was suggested by the rock-hewn tombs of Beni-Hassan in Upper Egypt, being, after all, unlike anything else in the world. But the numerous archeological investigations of the last few years have resulted in making it certain that many ideas, formerly conceived of as strictly Hellenic or Egyptian, were rather Mediterranean or even European. And it is fair to argue that the Greek temple had behind it something that was not necessarily characteristic of the ancient Nile or Ægean alone. The more we know about the prehistoric Mediterranean area, the less are we inclined to attribute to one race or to one people the chief contributions to human civilization arising within its bounds.

In 1905, in an article in *Globus,* the German geographical and ethnological journal, Professor K. Fuchs put forward the theory that "the wooden prototype of the Greek temple was an *Almenhaus,* the house of a rich cattle-breeder of the central European plateau, whom a long winter compelled to lay in great stores of hay and forced to erect over the stable a large hay-loft which kept it warm." To central Europe belonged in ancient times a house which was, "at the same time the primitive form of the modern Czik wood-houses, the ancient Greek temple, and several modern Alpine types of dwellings." Beginning with the gable, Professor Fuchs derives each prominent part of the Greek temple from corresponding portions of the prehistoric central European cattle-breeder's house, and really advances some very good arguments, as the illustrations to the article indicate, for the opinion held by him. Even the columns find their place in this explanation, but not so satisfactorily as in the later theory of Sarasin. That the Greek temple had a wooden prototype is now beyond doubt, but it is by

no means certain that its ancestor was the cattle-house of the natives of prehistoric central Europe, whatever their racial affinities were. Nevertheless, there are remarkable analogies between the prehistoric "winged house" and the ancient Greek peripteros. Fuchs's theory, however, is rather "local," and therefore not so widely applicable as that of Sarasin.

Dr. Paul Sarasin, who, with his cousin Fritz, is well known for notable researches among the primitive peoples of Ceylon, Celebes, etc., propounded before the Berlin Anthropological Society in 1906 a new and attractive theory of the origin of the Doric temple, viz., from the "lake-dwelling," or "pile-dwelling," characteristic of certain regions of the ancient and the modern world. His essay, with numerous illustrations, has since been published in the *Zeitschrift für Ethnologie*. It deserves the careful perusal of every student of the history of art and architecture, for his intimate knowledge of the "pile-dwelling," particularly in Celebes, enables Dr. Sarasin to go into very interesting details in this matter, and to set forth his arguments in a most striking manner, enforced by the illustrations, which are very much to the point, and also somewhat convincing. According to Sarasin, the Greek temple with columns "is a highly idealized and conventionalized expression of the original pile-dwelling"—the columns are the piles, the ornamented superstructure the dwelling fixed upon them, the triglyphs the window-strips, the metope the partition, etc. In order to fully appreciate the merits of Sarasin's theory one must bring up before the mind the wooden forerunner of the Doric peripteros: "The columns were wooden pillars, the architraves wooden beams, the triglyphs wooden strips, the metopes boards with carved ornament; the wooden roof was covered with mud-thatch, and the wooden ridge ended in a bird made of cut boards (the acroterion)." Reducing the height of the columns a little, and increasing somewhat that of the superstructure, one has a building strikingly similar to (in many respects identical with) the pile-dwelling. The figures of the temple of Poseidon at Paestum and a pile-dwelling in Central Celebes show this very clearly. And it should be said that the pile-dwellings of Indonesia, occurring on land as well as in water, represent better a "pile-dwelling period," than the "reconstructed" lake-dwellings of Switzerland. During the later stone age and the bronze age, Dr. Sarasin thinks, moreover, pile-dwellings of a sort comparable with those to be met with in Celebes, were found over a considerable portion of Europe, not merely in lakes, rivers, etc., but also in swamps, and on the dry land. Such a one was, apparently the pile-dwelling of the Wauwyl bog investigated in 1904, and closely resembling the Celebean pile-dwelling of the marshy Lake Limbotto. In all probability there existed commonly in Europe to the end of the bronze age, and sporadically (in

Hungary, for example) much later, pile-dwellings of the kind in question. In Greece and many other parts of the then known world, the original human dwelling was the house on piles, which, therefore, was also the first dwelling of the gods and the first temple—the orthodox temple, as Sarasin phrases it—was a pile-dwelling. In very ingenious fashion Sarasin shows how the peculiarities of the various portions of the Greek temple can be developed from the pile-dwelling. The megaron, too, finds an analogue in the *lobo,* or "men's house" of Malaysia.

The simplest form of the column is, of course, the pile driven into the pillar or resting upon it; the basis of the Ionic and Corinthian columns is to be seen in the stones placed under the piles to prevent too early decay, etc. The so-called *echinus,* the lower, round portion of the capital of the Doric column, corresponds to the round disc of stone or wood placed on top of the piles as a protection against rats, etc. The *abacus* has also its prototype in the pile-dwelling in the rest-piece for the beams, which is placed on the middle of the disc just described. The so-called proto-Doric columns of Egypt, which lack the *echinus,* go back, Sarasin suggests, to a pile-dwelling without such protective discs. The perpendicularity of the columns of the Ionic and Corinthian temples, as well as the slight upper inclination of the Doric, comes naturally enough from the conditions of the wooden piles and their arrangement. So also square columns and even fluting. The so-called *ædicula,* according to Sarasin, is derived, not from the tent, as some have supposed, but from the small shade-roof seen in front of many Celebean pile-dwellings, under which the occupants sit protected from sun and rain. The "wall-temples" and the *cellæ* are easily developed from the open space under the dwelling in the pile-houses by building in between the columns—the prototypes are seen in the Celebean houses. The transformation of the upper part of the pile-dwelling, when no longer used for habitation, into the superstructure of the Greek temple with its ornamentation (the frieze has its forerunner in the pile-dwelling's wooden carvings, etc.) was easily possible with an artistically-minded people. The substitution of stone for wood, Dr. Sarasin thinks, may have been an Egyptian invention.

If the present writer may be permitted to add to the ideas set forth by Dr. Sarasin, he would like to suggest the possibility of the existence of pile-dwellings in caves (such have been reported from prehistoric Sicily) having had something to do with the development of the original wooden pile-dwelling into the stone temple.

The theory of Sarasin has the advantage of proposing as the original prototype of the Greek temple something that was more or less cosmopolitan, a building that was common and natural over a large portion of the prehistoric world, and not some merely "local" model.

As Dr. Sarasin points out, the pile-dwelling served also as prototype of the Chinese and Japanese temples (in this case, since they are mostly constructed of wood the likeness is even more striking); likewise in Farther India, Hindustan, Arabia, Asia Minor, Egypt, etc., and even in prehistoric America. Moreover, not merely the "long temple," but the "round temple," goes back to the pile-house, as may be seen from the round pile-dwellings ascribed to the land of Punt, in Egyptian pictures dating from ca. 1500 B.C., which are practically identical in shape, etc., with pile-dwellings still to be seen in the Nicobar Islands and in certain parts of Africa.

Taken altogether, Sarasin's essay is one of the most interesting and suggestive contributions to the literature of the evolution of architecture that has appeared in a generation, and it illustrates the way in which the anthropological investigator can assist in the solution of many puzzling problems, which meet with no successful interpretation at the hands of the closet-student or the biased classicist. Dr. Sarasin has given but another proof of the fact that the highest genius of the ancient Greeks lay not in inventing great or beautiful things out-of-hand, but in idealizing, beautifying and harmonizing what had already long existed in common and wide-spread forms and fashions. And to that great art no human race is utterly a stranger; and many of them are much nearer the Greeks than most of us believe.

FERTILITY AND GENIUS

By CHARLES KASSEL
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MR. ROOSEVELT'S measuring of swords with the followers of Malthus has been so much used as a butt for mere jest that it seems difficult to approach the subject in a serious mood. To the thoughtful mind, none the less, the question is one of absorbing interest. With the economic phase of the problem, we are all, of course, familiar—the least informed needs no one to tell him that the more numerous the offspring the severer the strain upon the material resources of the family. It is with the psychological side of the matter that our chief interest is bound up. Does a large progeny mean a heightening or weakening of intellectual force in the offspring? Does it imply characteristics of temperament and disposition which we need not look for in the scions of smaller families? Upon this subject we are without data save such as are afforded by the pages of biography; but if the facts we gather from the lives in our libraries are a safe guide to a conclusion upon this question our worthy executive may well congratulate himself upon his insight and philosophic wisdom.

We have examined some hundred or more biographies of noted characters—the most eminent, as we deemed, of those whose lives were accessible—and, of these, seventy-six mentioned the number of children making up the family of which the personage treated was a member. The data thus obtained we have tabulated in order, with the following result:

Horace Walpole—historic in English annals for political astuteness—was one of nineteen children.

Benjamin Franklin was one of seventeen children.

John Marshall—that greatest of American jurists—was one of fifteen children.

Peter the Great—the monarch to whom Russia is in great part indebted for what she is to-day—was one of fourteen children.

Napoleon Bonaparte—one of the most colossal figures in history—was one of thirteen children, as was also Samuel Taylor Coleridge, the English poet.

Samuel Adams, the American patriot and statesman; Sir Walter Scott, the English poet and novelist; the American writer James Fenimore Cooper, and, last, but greatest of all, Alfred Tennyson—that

minstrel of a many chorded harp—belonged to families of twelve children.

Lord Nelson, the English admiral; Washington Irving, the American essayist, and James Buchanan, aforetime president of the United States, were members of families of eleven children.

The number ten, perhaps, enjoys a prouder boast than any other, for among those who can claim membership in families of that number are the mighty names of George Washington, Daniel Webster, Samuel Portland Chase (whose father, we may observe in passing, was one of nine sons), Henry George, Thomas Carlyle and Oliver Cromwell.

Of those historic characters who were members of families nine in number, illustrious examples are Thomas B. Macaulay (whose father was one of thirteen children and whose grandfather was one of fourteen children), Charles Sumner, General Sam Houston, Albert Sidney Johnston, Robert E. Lee (whose father was one of eleven children, Patrick Henry and ex-president Grover Cleveland. Mr. Cleveland's ancestry is one truly remarkable for the very numerous offspring of which his progenitors became parents for generations reaching back to colonial times—far the most remarkable of all we have discovered. Moses Cleveland, a remote ancestor of the ex-president, was the father of eleven children; his son Aaron was the father of ten; the latter's son Aaron was likewise the father of ten; this Aaron's son of the same name was also the father of ten; a son of the third Aaron, also of the same name, could claim an additional son for each of the three preceding him, for he was the proud parent of thirteen children; a son of this Aaron, named William, became the father of Richard, who in turn became the father of Grover. It is thus apparent that Mr. Roosevelt's warm interest in the ex-president springs not altogether from a high opinion of his talents or his services.

Thomas Jefferson, Thomas H. Huxley and Charles Dickens were each one of eight children, while James Madison, Henry Clay, Samuel J. Tilden, Paul Jones, Martin Luther, William Wadsworth Longfellow and William Cullen Bryant were members of families consisting of seven. As characters coming from families of six we find W. H. Seward, Lewis Cass, John Milton, Thomas DeQuincey, William E. Gladstone and Rufus Choate, while Noah Webster, William Wordsworth, Cardinal Richelieu, John Keats, James Russell Lowell, Ralph Waldo Emerson, Robert Fulton, Gustavus Adolphus and Louis Agassiz —a goodly company, it must be owned, but only three more than those springing from families of ten—were each one of five children. The number four lays claim to the names of Charles Francis Adams, the Duke of Wellington, Henry D. Thoreau, John G. Whittier, Balzac and

Christopher Columbus, but of Whittier it must be added that his father was one of eleven children, his grandfather one of nine children and his greatgrandfather one of ten children. Constituting one of a family of three was Abraham Lincoln, Edgar Allen Poe, David Hume, Victor Hugo, Robert Browning and Edmund Burke. Albert Gallatin, Alexander Pope, Lord Byron, J. J. Rousseau and Aaron Burr make up the personages who can claim but a single brother or sister, though the mother of Alexander Pope, it is worthy of mention, was one of seventeen children. William M. Thackeray, Robert L. Stevenson, John Ruskin (whose father was likewise an only child) and Alexander Hamilton were single offspring.

A studied effort to swell the larger numbers by reference to biographies other than those mentioned would, it is needless to say, have added many a name to the lists, and fuller inquiry might show that of those whose names appear among the smaller numbers not a few could boast an ancestry noteworthy for numerous offspring, as in the case of Whittier, Pope and others. It has not, however, been our purpose to warp biography in the remotest degree to support or to refute a theory.

By casting together the historic names we have given and dividing the gross number of children by the total number of names we arrive at a figure a fraction less than seven—a number which we believe the statistics of population will show to exceed by not a little the number of children in the average family. It is true, of course, that statisticians, in computing the average number of children in families at large, would consider in the calculation families wholly without children, which would make the disparity less glaring—none the less the average progeny in families from which eminent personages have sprung would still be so large as to be striking.

It is apparent, upon a careful study of the figures we have given, that those who were members of large families were in general distinguished for great firmness of character—such as Napoleon, Peter the Great, Cromwell, Nelson, Washington and others. This is perhaps explained by the self-dependence one of many children reared by the same parents would acquire in the course of his youth; and the necessity of accommodating his enjoyments to those of his numerous brothers and sisters would serve a highly useful purpose in teaching him self-control, and also, perhaps, in teaching him resourcefulness. Among those, on the other hand, who were single children, or one of but two or three, no few displayed precisely the opposite qualities. However, we indulge in no theories—we call attention to the facts merely. Some reader of inquiring mind, perhaps, may be tempted to explore the subject farther.

THE PROBLEM OF AGE, GROWTH AND DEATH

By CHARLES SEDGWICK MINOT, LL.D., D.Sc.
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V. Regeneration and Death

Ladies and Gentlemen: In the last lecture I treated the conception I had formed of the processes of regeneration and told you that I looked upon the change which occurred first in the developing germ as one of rejuvenation. The process has for its technical name the segmentation of the ovum. The appearance of this segmentation process was illustrated to you by the pictures thrown upon the screen. Cytomorphosis is a term which we have frequently used in the course

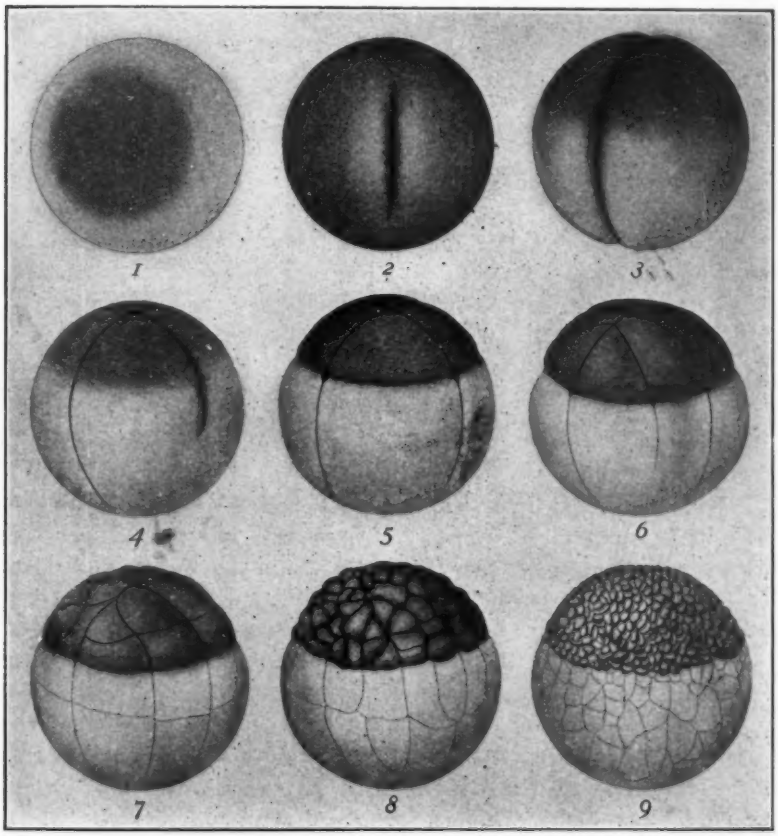


Fig. 51. The Segmentation of the Ovum of *Amblystoma punctatum*, to show the earliest phases of development in the egg of a newt. After A. C. Eycleshymer.

of these lectures, and I have led you, I hope, to the appreciation of the idea that in cytomorphosis we have at least a part of the explanation of old age. We have learned that the young cells which are produced by the segmentation of the ovum in the body in large part changed into old cells, and also that old cells can not go back in their development and again become young; so that one might easily be led to the suspicion that there could be no possible new young, a conclusion obviously absurd, for there is a constant renewal of the generations. Some

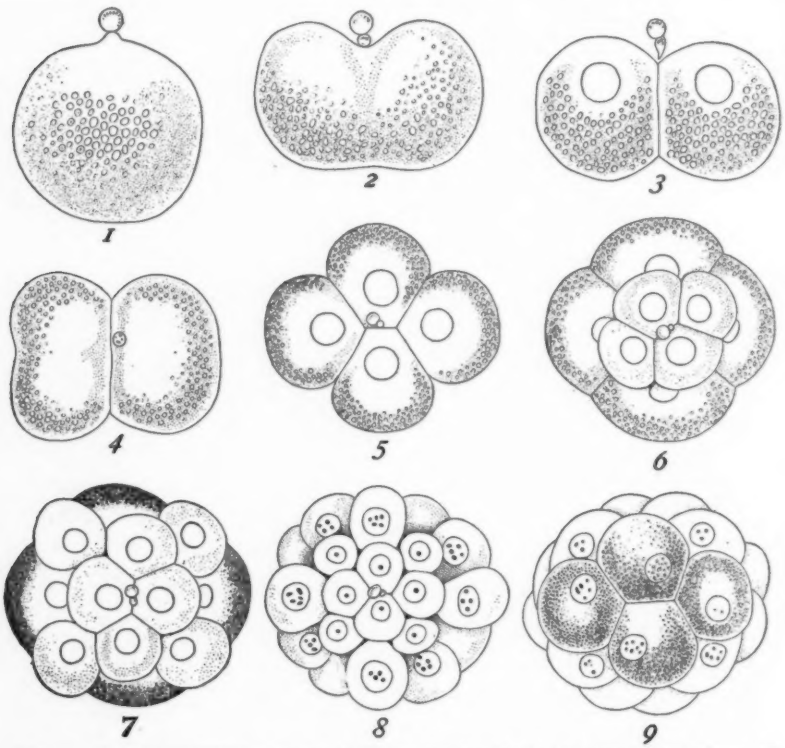


FIG. 52. THE SEGMENTATION OF THE OVUM OF *Planorbis*, to show the earliest phases of development of the egg of a pond snail. After Carl Rabl.

device, therefore, must exist by which that which is young is perpetuated, for that which is old can not again become young, and of that device I should like to say something this evening.

As a preliminary to the discussion of this interesting phenomenon, it is necessary to say a few more words in regard to the nuclei. You recall that the units, out of which the body is constructed, the cells, consist each of a little mass of protoplasm with a central body called the nucleus; and you will, I hope, recall that the increase of the protoplasm and the subsequent differentiation of the cell we looked upon as the cause of old age, and the increase of the nucleus as the cause of youth, of rejuvenation. In addition to what has been said concerning

the size of the nucleus, some further explanation is necessary, and that can best be given with the aid of some illustrations upon the screen. The first of the pictures will, I hope, serve to recall to your minds what I said in regard to the process of the segmentation of the ovum. Here is an ovum, No. 1, a single cell, but relatively of enormous size, the ovum or germ of a newt, and the plate illustrates to us the gradual process of division of the original single cell into a number of distinct cells, and each of these we call a segment, and the formation of them, segmentation, a name which we keep from the olden time when the process was first observed by some French investigators, because it is so descriptive of the appearance presented to the eye by the changes which are going on. Were we to name the process now we should certainly call it a process of cell production.

The next of our pictures shows us the eggs of a common snail, the Planorbis, a little fresh-water snail, the coils of which lie flat in one plane—hence its name. No. 1 is the original germ; No. 2 shows it about to divide into two; No. 3 is a side view; No. 4 a top view of the ovum with two segments; No. 5 is cleft into four segments; No. 6 into eight. Nos. 7 and 8 illustrate the further progress of the cell multiplication; No. 9 represents the under side of the same egg of

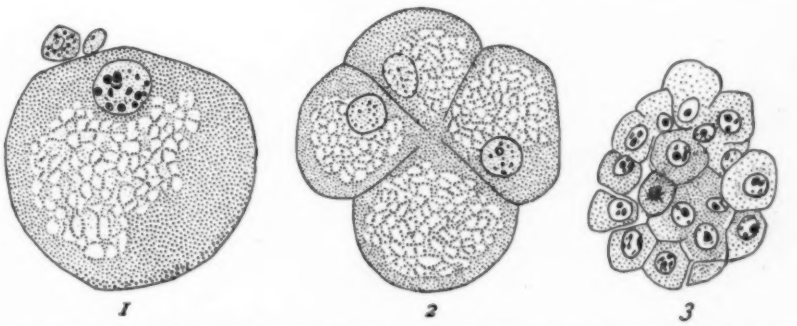


FIG. 53. THREE SECTIONS THROUGH THE SEGMENTING OVA OF A MAMMAL, *Tarsius spectabile*. 1, ectoderm; 2, mesoderm; 3, entoderm; 4, Hensen's knot; 5, entoderm; 6, mesenchyma; 7, entoderm; 8, medullary groove; 9, ectoderm; 10, large motor neurone; 11, spinal ganglion; 12, mesenchyma; 13, cartilage; 14, Wolffian body; 15, kidney; 16, striated muscle; 17, heart muscle; 18, esophageal entoderm; 19, tracheal entoderm; 20, liver; 21, entoderm; 22, motor neurone; 23, spinal ganglion; 24, dermis; 25, hypodermis; 26, cartilage; 27, 28, Wolffian tubules; 29, pelvis of kidney; 30, heart muscle; 31, esophageal entoderm; 32, tracheal entoderm. After A. A. W. Hubrecht.

which the top is figured as No. 8. The number of cells (segments) is thus constantly increasing and already it is evident that they have become somewhat unlike in character. Were the picture still further magnified, we could see that in these cells a change is going on in the nuclei which, however, I can better demonstrate to you by means of the following picture, one which we saw in the last lecture. These are sections through the early developing germ of a mammal named *Tarsius spectabile*. It is a creature nearly related to the lemurs, having

a special interest to naturalists, owing to the fact that in its early development it offers features of resemblance to man which are very striking and instructive. The plate is from a series of drawings made under the direction of Professor Hubrecht, the principal student of the development of this type of animal. Here (No. 1) we can see an early stage in which the germ consists of but a single cell, and at this point is the nucleus. Note its size and then compare it with the nuclei in Nos. 2 and 3 in which several of these cells, as they appear in a section, are represented. The cells themselves are now smaller because they have multiplied by the division of the original germ, but the nuclei in them are likewise smaller. And in the older stage, No. 3, where the number of cells has begun still further to increase, we see that there is another and more marked reduction in the size of the nuclei. Contrast the single nucleus of the early stage with the small nuclei of the later one, and notice how very striking is the change in the size. Thus during the early development of the individual, and it seems to be true of all animals, we find that there is an actual rapid reduction in the size of the nucleus. As we have learned that the proportion of the nucleus and the protoplasm is so important, we must attribute to this alteration in the dimensions of the nucleus great significance.

We have next a series of figures which have interested me very much and which I only recently secured as the result of studies I have been making in my own laboratory at the Harvard Medical School. These pictures are now shown publicly for the first time, and record a fact which, so far as I know, has never yet been clearly noted and recognized as important by any investigator. The four figures at the top represent four single nuclei taken from different parts of a rabbit seven and one half days after the commencement of its development. The second set of figures, 5, 6, 7 and 8, show nuclei from different characteristic parts of a rabbit embryo of ten days. Note, please, the size of these nuclei, the curious network of threads in their interior and the existence, generally more or less in a central position, of a mass of material which stands out conspicuously and represents a condensation of the nuclear stuff at that particular point. Such a central body is highly characteristic of these early stages. Next we come in the series of figures, from 9 to 20, stretching across the screen in two lines, to a rabbit embryo of twelve and one half days. Instead of having nuclei of large size we have now nuclei which are obviously small. Instead of having nuclei which are more or less alike in appearance, we have now nuclei of great diversity. Every one of these figures, as you will readily see if you run your eye along from one end of the lines to the other, has a distinctive character of its own. In this period, then, of two and one half days, there has been a revolution in the character of the nuclei of the developing embryo. Where before the nuclei were alike, now they have become unlike. Two of these I

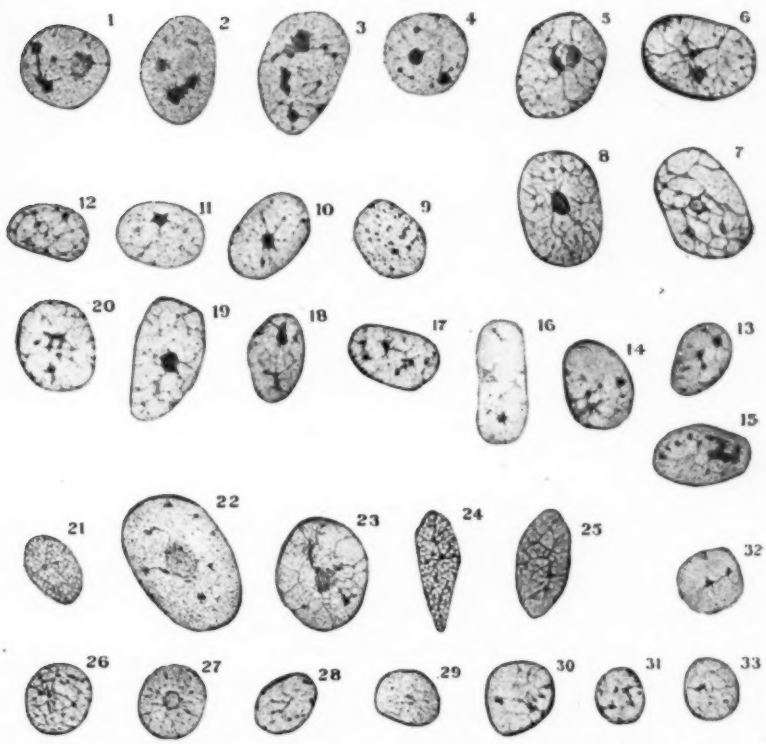


FIG. 54. NUCLEI FROM RABBIT EMBRYOS. 1-4, age, seven and one half days. 5-8, age, ten days. 9-20, age, twelve and one half days. 21-33, age, sixteen and one half days.

should like especially to call your attention to, because they are the nuclei of the nerve cells—this one, No. 11, from the spinal cord and the right-hand one, No. 10, from the cluster of nerve cells upon the root of a spinal nerve. Finally, we have the series of figures from a rabbit of sixteen and one half days represented in the two lower rows, 21 to 33. In these, if you will leave aside from consideration for the moment 22 and 23, which are obviously of a different size, all are now smaller than they were at twelve and one half days. Every one of the nuclei here represented is characteristic. We have here, for instance, nuclei of the excretory organ; a nucleus of the connective tissue; we have nuclei from the lining of the wind-pipe and the lining of the gullet. Every one of them differs from every one of the others pictured. But if we had drawings of a number of nuclei from the same part of the body and same kind of tissue, we should see that they would be essentially similar. We learn then that there is acquired a great diversity in the structure of the nuclei as well as in that of the protoplasm, of which we have seen so many examples in the previous lectures. You will recall, that as regards the size of cells the nerve cells present a noteworthy excep-

tion in that they differ according to the size of the animal; and their nuclei differ also, for as the cells become big the nuclei grow likewise. Here are nerve-cell nuclei in the rabbit of twelve and one half days not differing in their dimensions essentially from the nuclei of other types, but in the two lower figures, 22 and 23, we see nuclei corresponding to the cells of the rabbit at sixteen and one half days. These cells have begun to enlarge, to assume the greater dimensions of the nerve cells, which is characteristic of the rabbit; and accompanying the enlargement of the cells there has been an expansion of the nuclei also. But this does not affect, as you will readily see by the pictures upon the screen, the nuclei of any other sort of tissue, the nuclei of any other organ of the body.

We must therefore add to our conceptions in regard to the relations of the nucleus and protoplasm, as quantitatively expressed, this further notion that there is during the early period of development an actual reduction in the size of the nucleus. When this reduction has taken place it is of course evident to any one at all acquainted with the principles of cytology that the cells are in a very different state from what they were in before. They are no longer such cells as they were when the nucleus was large, and the nuclei in the different parts of the body alike in character. Here the relations are fundamentally changed. We do not find that these nuclei ever get back from the complex variety of organization which they present to us in later stages to the earlier condition when they were all alike; yet only with cells of this uniform sort can development begin. We should therefore, if we reasoned only from the data which I have thus far presented to you, come to the conclusion that reproduction would be impossible, that the cells of the body, having been so changed, as we have seen, are no longer capable of returning backwards along the path they have journeyed; they can only remain where they are, or go yet further onward in the career of cytomorphosis. Nature, however, has met this difficulty by a way which we have only recently discovered. We are not yet sure that the way we have discovered is the only way, that it is the universal method in the case of all animals for accomplishing the purpose. The discovery of this method of providing for the perpetuation of youthfulness from one generation to another, the youthfulness of the cell of man, is due to the investigations of Professor Nussbaum, of Bonn. The theory, which he put forward, has been verified by subsequent examinations and investigation, and confirmed, I am glad to say, in part by some very interesting and careful observations which have been made here in Boston. Perhaps the very best confirmation of all is the recent extension of our knowledge in regard to this theory which comes from the investigations of Dr. B. M. Allen, made at Madison, on the process as we find it in the developing turtle. It is really essentially a very simple thing. Nature seems to take some of the cells which are in the

primitive condition, with the protoplasm still undifferentiated and the nucleus of the embryonic or simple organization, and hold them apart from the rest of the body, not separating them so that they come off and leave the body, but so that they have a different history; so that they escape the change which the other cells of the body must pass through. These cells of a simpler character are gathered together, kept asunder, and not allowed to progress in the development of all the cells which form the body proper. We have learned, for instance, that in the development of the dog-fish very early, before any organs exist, cells are formed into a cluster. They lie by themselves, are easily recognized under the microscope, and they have obviously the primitive character which I have endeavored to explain to you. And they remain such. Meanwhile as development progresses, all the remaining cells—all those not part of these clusters, pursue their proper careers, become differentiated; but the cells in the clusters do not change for a long period. Later as the organs become differentiated, we can recognize in the direct descendants of these cells, which have been traced from stage to stage so that their history is known with certainty, those cells which in the adult we call the germ cells, and which are to serve for the reproduction of the species. These cells are set apart at all periods. They represent germinal matter which is withheld from the metamorphosis which the rest of the body undergoes. They have a continuous history. Hence we bestow upon this method, under the conception that it is applied to secure propagation of the species, the term—theory of germinal continuity. It is the theory of hereditary transmission which I think is now universally held by all competent biologists. Our study of nuclei and of their relations to protoplasm serves to clear up in our minds, it seems to me, to some degree at least, the necessity which really exists for this device of germinal continuity, of the setting apart of certain cells of the rejuvenating sort, of the young sort, of the embryonic type (the term you apply to them matters little), which cells are those used to produce the new offspring of the next generation. All this, of course, fits perfectly with the doctrine which I have been telling you of again and again in this course of lectures, that the progress of differentiation is always in one direction and ends in the production of structure which, if it is pursued to its legitimate terminus, results in the degeneration and death of the cell. Obviously such a set of changes as I have thus indicated can not produce the sort of a cell which is necessary for reproduction.

I wish there were time to enter more fully into this question of the size of nuclei, for there is much which might be said concerning it. This much more, however, ought to be said to you—that the problem of the size of nuclei is by no means a simple one. It has been found, for instance, in the experiments made upon some of the simple algæ, the so-called *Spirogyra,* which every elementary student of botany probably

has looked at in the laboratory, that by certain artificial conditions, as made in the experiments of Professor Gerassimow, the size of the nucleus can be changed in the cells, and when the size of the nucleus is changed, the size of the cell alters also. And again, we know that the nucleus provides certain chemical supplies for the life and functioning of the cells. This is very strikingly the case, for instance, in regard to the cells which secrete. These, when they give off the material which they have accumulated in their protoplasm as a preparation for the act of secretion, are found not only to reduce the bulk of their protoplasmic bodies, but the bulk of the nuclei as well. And we know again that the size of nuclei may be changed by somatic conditions, by food supply, so that in every generalization reached by the study of the size of nuclei, we must be very circumspect, and not fancy too easily that we have reached a safe conclusion unless we have taken into consideration all the possible factors by which the size may have been varied.

In what I have said to you hitherto in regard to the power of growth, I have directed your attention chiefly to the power of growth as it exists in a cell in consequence of that cell's condition. When the cell is in the young state, it can grow rapidly; it can multiply freely; when it is in the old state it loses those capacities, and its growth and multiplication are correspondingly impeded, and if the organization is carried to an extreme, the growth and the multiplication of the cell cease altogether.

We find, however, that there is something a little more complicated yet to be considered, for it is not merely a question of the capacity of the cells, but also of the exercise of that capacity, which we must deal with. Here comes in a factor which we learn from the study of regeneration. The phenomena of regeneration are very important and very instructive. We shall come to those in a moment. It will make our study of regeneration clearer, more significant, I think, if we pause for a moment to consider certain fluctuations in the natural development of the organism. We see, for instance, in the brain that early the cells begin to assume the character of nerve cells and that thereafter their multiplication ceases. But, curiously, there will be a spot in the spinal cord, for example, where the change of the cells into nerve cells has not taken place, and from that growth will go on. Cells will migrate from that spot and reach their ultimate destination. When the child is born it is very incapable of movement. There is scarcely more than the power of twitching about in a disorderly fashion. Its muscles can contract, to be sure, but any sort of motion that implies a harmonious working together of various muscles, the baby at birth is quite incapable of. This phenomenon is doubtless due to the fact that the cerebellum, the small brain, is as yet imperfectly developed. If we examine the brain of the child at birth, we find at the edge of the cerebellum a line

along which the production of new cells is going on. These new cells migrate over the surface of the cerebellum without changing at all into nerve cells. They form a distinct layer which is well known to every investigator of brain structure, and presently after birth these cells accomplish a second migration, but in a different direction. Instead of moving in a constant current over the surface of the brain, each one takes a vertical pathway from the surface down towards the interior of the cerebellum; and arrived there it changes and becomes a nerve cell, or at least a part of them do; and with that the machinery of the cerebellum is complete. Thus, structurally, the cerebellum at birth is an uncompleted organ. Now, the cerebellum is that portion of the brain which regulates the combination of muscular movements, which secures that which the physiologists term coordination of movements, and it is not until the cerebellum has been perfected that it can perform this function. Were there not some provision of this special sort for allowing cells to be produced and added to the brain, the full complexity of the brain could not be attained, because after the cells have begun to change into nerve cells they lose their power of multiplication, and this is a device very exquisite in its working to supply to the brain the requisite number of cells to give it its full measure of complexity.

Another instance of the reservation of cells of a simple type is afforded us by the skin, about which I shall have something more to say in a few moments when we speak of the process of regeneration. It is not only in the period of childhood, and not only in the cerebellum, that we find cells exist such as I have just described to you, but it is in other parts of the body also and at other periods of life that we find the like phenomena; and in part I have already referred to these. You remember I told you in a previous lecture there is always in the body, even at the extreme of life, a store of cells of the young type, which is garnered in the marrow of the bones. The cells in question can multiply, and their descendants in part undergo a change in consequence of which they are converted into blood corpuscles. The undifferentiated or young cells are preserved in the marrow precisely for the purpose of making up the necessary number of blood corpuscles to replace those which are lost either by accident or in consequence of normal physiological processes. I mentioned to you that in the lining of the intestine there is a constant loss of cells and we find in every simple gland of the intestine, in every little gland of the stomach, a center for cell production, a center where there is a group of cells which are not differentiated, but retain their simple organization.

I could multiply these instances almost indefinitely, but perhaps it will be better to call your attention to an illustration of quite a different sort. We know that in order to have a very complex organization, the number of cells in the body must be very large indeed. Obviously a

small insect, a mosquito or a little beetle, whatever it may be, is not big enough to have a great many cells; and, unless it has a great many, it can not attain the differentiation of complicated organs such as we possess. Now, the lower animals are born, so to speak, early, and as soon as they hatch out, they have to support themselves. We see that, for instance, in caterpillars. They are born very little creatures, but each caterpillar must look out for itself, obtain its own food, move about to that food, must, when the food is swallowed, digest it, and must carry on the correlated functions of secretion and excretion; it must breathe. In order to do all this the larva, or young caterpillar, to follow our special instance, must have some differentiation already established; but, as we have already learned, differentiation impedes growth. In other words, in such a larva the multiplication of cells is held back by the very demands of the conditions of its existence. If it is to have organs which are to function, it must have differentiated parts, and, if it is differentiated, its growth power must be sacrificed.

Now how has nature proceeded in order to produce a higher type of animal, one in which the number of cells is much greater? Very ingeniously. She provides the developing organism with a food supply which it carries itself. If, for instance, you recall the egg of the salamander, which I showed you upon the screen, you will remember that that is a structure of considerable size, and its size is due to the accumulation of food material, material which we designate by the term yolk granules, which lie in the living protoplasm of that germ. This supply of food is so great that it will last the organism a considerable period. While it is growing it has nothing to do but to digest that food supply which it already possesses. It does not have to exert itself to obtain it, and no further digestive process is necessary than that inherent in all living protoplasm. So the young salamanders develop in a most advantageous condition, and can actually produce a much greater number of cells because it is possible, with this internal food supply, for the growth to go on only with the cells of the embryonic or youthful type for a considerable period, and then, when their number has considerably increased, steps in the process of differentiation.

In the higher animals this accumulation of food for the nourishment of the germ is carried yet further. As you know, the egg of the bird is much bigger than that of the salamander, and in the highest animals, in the mammals, there are other special contrivances which nature has introduced to secure ample and adequate nourishment of the developing germ. There the perfection of the process is made yet greater and in these forms there is a long period during which the production of cells goes on; the cells all remain simple, and by the time they begin to change the number of cells is so great that the possibilities of an infinite variety, almost, of peculiarities in them are given, and

there are cells enough to allow this variety to be worked out. This we call the embryonic type of development.

We see, therefore, that nature has recognized a restriction which she herself has put upon development, the restriction which obliges development, if it is to be ample, to prolong the accumulation of the undifferentiated cells. In response to that condition, she substitutes for higher types of animal that development which we call embryonic, leaving for the lower type that which we call larval. Thus we see in the growth and formation of the higher animals and in the history of the comparative development of the animal kingdom, fresh illustrations of the great importance of the young type of cells.

We can see the same thing also in regard to regeneration. The regenerative process depends to a large extent upon partial differentiation, or even upon its total absence. Regeneration is a most interesting and wonderful process. I took pains only this afternoon to look at that famous classic by the Dutch Abbé Trembley on hydroids or polyps as he calls them. "The Fresh Water Polyps," a book published in 1744, was well printed, and on such good paper that it looks to-day

FIG. 55. VIGNETTE FROM TREMBLEY'S CLASSIC MEMOIR, representing Trembley making his experiments on regeneration in fresh-water polyps.

almost like a new book. He made the curious experiment of cutting one of these minute fresh water polyps—they are perhaps an eighth of an inch long—in two, and made the startling discovery that each half of the polyp would make up what the other half had deprived it of; each half, in other words, would become a new polyp. That which was lost was regenerated. After him came a series of yet more remarkable experiments by the famous Italian naturalist, Spallanzani, one of the masters of experimental research, and he discovered that regeneration was a property which was not peculiar by any means to polyps,

but existed in the earth-worms, and even among vertebrates; for he it was who discovered that if the head of an earthworm be cut off, the worm will form a new head with a new brain and a new mouth. He first discovered that if you cut off the tail of a salamander a new tail will grow out. He it was, moreover, who discovered that this power of replacing the lost part is greater in the young—greater in the earlier stage than in the later. This indicates in a general way the nature and process of regeneration. We have many kinds of regeneration; we may have that of the single cell or that of the whole organism.

We pass now to the next of our slides, which represents a creature of the kind called *Stentor*. It is a single cell. Here is the nucleus of

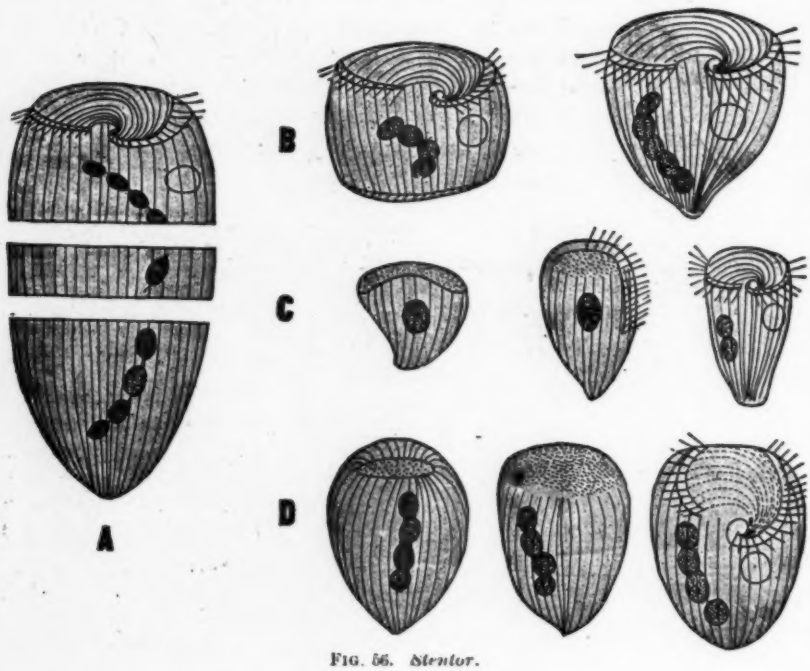


FIG. 56. *Stentor.*

the cell; its protoplasmic body is large, and something of the structure of this I have told you in a previous lecture. A German investigator, Professor Gruber, has succeeded in dividing one of these *Stentors*, a unicellular creature, animalcule, common in fresh water, into three parts in such a method of cutting as is illustrated by the figure on the left. Each of the three parts will then restore itself and become a complete *Stentor*. In such experiments the protoplasm over the nucleus begins to grow; gradually the original form is again assumed; the creature grows larger and larger, until each piece acquires the parent size, and, so far as we can see with the ordinary microscopic examination, identically the parental structure. That which was lost

has been regenerated. We learn, then, that regeneration is a faculty which a single cell, a single unit, may possess.

Our next picture demonstrates a similar phenomenon. These are muscle fibers which have been injured. Now every muscle fiber contains in its interior its contractile substance, in regard to which I have already spoken to you, but it also contains a certain amount of substance which is still undifferentiated protoplasm. Now when a

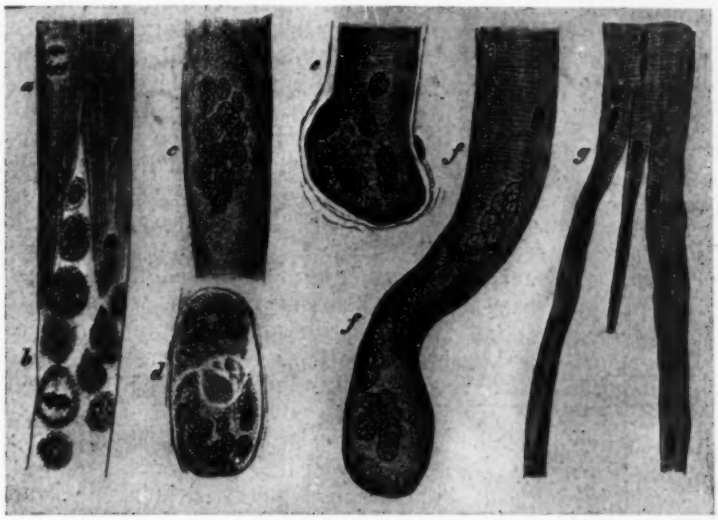


FIG. 57. STRIATED MUSCLE FIBERS IN PROCESS OF REGENERATION.

muscle fiber of this sort is injured, we find that the muscular structure, properly so called, will in many cases quite disappear, but then the protoplasmic material, which is the undifferentiated substance, will begin to grow, and the nuclei will begin to multiply. This may happen at the end of a muscle fiber, producing there a considerable mass of protoplasm, with nuclei multiplying in it, or we may find a chain of nuclei, each with its separate court of protoplasm body; such nuclei will multiply. When the increase of the undifferentiated protoplasm has gone on far enough, the injured muscle will produce again the muscular substance proper—the contractile fibrils. Muscular fiber, in other words, can be regenerated by itself.

A similar thing to this happens when a nerve is cut across. The nerve fiber, which is connected with the nerve cell from which it arose, is capable of growing out again. It can regenerate itself, and that is a well-known phenomenon, and in many surgical cases it becomes a phenomenon of very great importance.

Let us go back to another familiar figure. Here is represented the lining layer of the œsophagus with the cells composing it, the upper ones being horny, the lower ones those which are capable of active

growth. We are rather dull. We do not often stop to think about things. We buy a new horse which comes from the country, has never seen a train; drive him to the station, and are frightened, perhaps, because the horse himself is so much alarmed—possibly have a narrow escape because of the excitement which his first sight of a train causes him. But that horse, after a few months' discipline, will scarcely turn his ear, much less his head, to look at the train which a short time before so frightened him and held his attention that nothing else could get into his mind save the fright that train gave him. So we, too, act a good deal like the horse. We see a thing the first time and it surprises us; the next time it seems like an old acquaintance, a thing

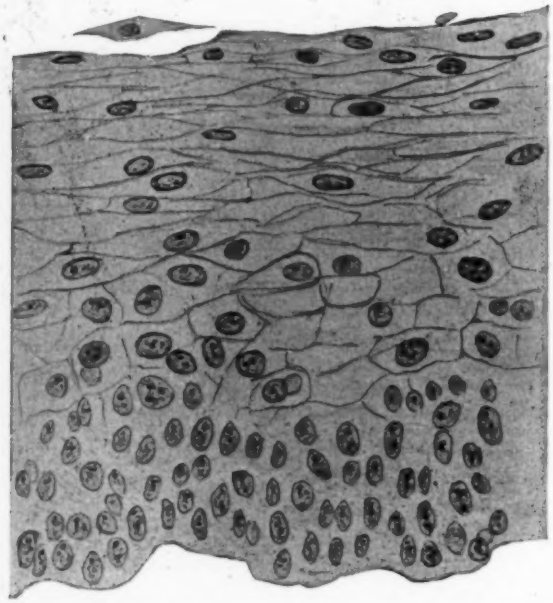


FIG. 58. SECTION OF THE EPITHELIAL LINING OF THE HUMAN ŒSOPHAGUS.

familiar and therefore unregarded. I say this apropos of the skin. How many of you have thought what the lesson of the skin is in regard to the power of growth? Spring is coming; we shall soon be taking to our boats, rowing or canoeing, and the first day we do so doubtless we shall have blisters upon our hands, and the outer part of the skin, raised by the blister, will probably fall off and be lost altogether. The softer, underlying skin will be exposed, will be sensitive and uncomfortable for a while, but soon the cells behind the surface will assume a horny character, the cells underneath will grow and multiply, and presently the wound will be healed over. Did you ever stop to think that that means that there is a reserve power of growth in the skin all the time? always ready to act, to come forward, waiting

only for the chance, and that there is besides something which keeps it in, which holds it back, which stops it? We call this stopping physiological function—inhibition; we say that the growth of the skin is inhibited; though in the deep part of the skin all the time there are the cells ready to grow as soon as that power of inhibition is taken away; while it is active they will not grow. The simple blister tells us all that. There is, then, a power of regulation which expresses itself in this inhibitory effect. When a salamander has its tail cut off by the experimenter and the new tail grows, just enough is produced. The new tail is like the old. The tissues grow out until the volume of that which is lost is replaced, and then they stop. But if the tail should be cut off again, regeneration would occur again. The experiments may be repeated many times over. It indicates to us that always the growing power is there, but it is held in check. What that check may be is one of the great discoveries we are now longing for. The discovery, when made, is likely to prove of great practical importance. The phenomenon of things escaping from inhibitory control and overgrowing, is familiar. Such escapes we encounter in tumors, cancers, sarcoma and various other abnormal forms of growth that occur in the body. They are due to the inherent growth power of cells kept more or less in the young type, which for some reason have got beyond the control of the inhibitory force, the regulatory power which ordinarily keeps them in. No picture of the growth or development of the living animal would be complete if it confined its attention only to the power of growth in relation to cytomorphosis. It must also include the contemplation and study of this regulatory power of the organs. Experiments are being made in many places, minds are at work in many laboratories upon this problem of regulation of structure and growth. Much is to be hoped from such researches; not merely insight into the normal development, but insight also into the abnormal. Nothing, perhaps, is more to be desired at the present time than that we should gain scientific insight into the regulatory power which presides over growth. It would be of immense medical importance. Could we understand it, and could we from our understanding derive some practical application of our scientific discoveries in this field, we could say of it justly that it was as noteworthy a contribution to medical knowledge as the discovery of the germs of disease, and would doubtless prove equally beneficial to mankind. Although, then, the study which I have been laying before you must necessarily seem in many respects abstruse and far away from practical applications, we learn that it is not really so, and that it leads by no very remote path to the consideration of problems the useful applications of which are immediately obvious to every one.

We find in the process of regeneration that it is always the young cell which plays the principal part. This is beautifully illustrated in

the picture upon the screen. There is a little creature, which many of you have seen in the garden, consisting of joints, which rolls itself up into a little ball, and therefore is often called the "pill-bug." It is not, however, an insect or a bug, properly so-called, but belongs to a family of crustaceans. It has on its head a little feeler which we call the antenna. The particular kind of arthropod, the antenna

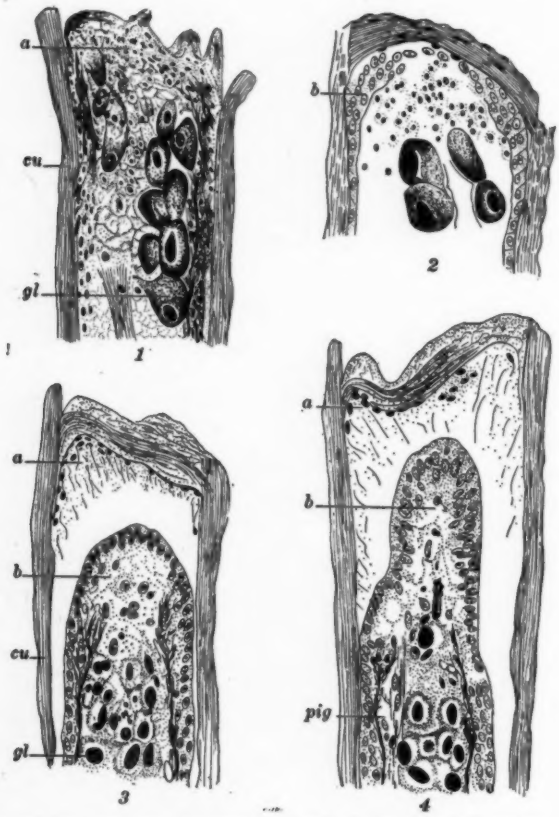


FIG. 59. SECTIONS THROUGH THE ANTENNA OF *Oniscus* IN VARIOUS STAGES OF REGENERATION AFTER AMPUTATION. After Ost.

of which has been studied and drawings of it made to furnish us this plate, is known by the name of *Oniscus*. In his researches the experimenter, Dr. Ost, cut off the antenna in the middle of a joint and found that it rapidly healed over. Here is pictured the process of healing going on. Part of the antenna has been cut off in this case, the wound was healed over here, No. 1, *a*, the new tissue has begun to grow, No. 2, *b*, and the cells at this point are very simple in character. They spread out and grow, and then, within the interior of the hard shell of the feeler, a retraction of the substance occurs, and the new growing cells within this space gradually begin to shape themselves out,

No. 3, *b*, and we see presently an accumulation of cells which is assuming a definite form, No. 4, *b*, that in the next figure has clearly become the promise or beginning of a new terminal joint, Fig. 60. The minute study of this process has shown that the regeneration depends practically exclusively upon the cells of the young type, and that after they have grown out and accumulated here in this manner, No. 3, *b*, some of them undergo differentiation, becoming muscle cells; others change in the manner indicated here, where we see a commencing alteration of the nuclei, which is further accented in Fig. 60, and leads to such a grouping of the cells that the glands, which were originally present there, are also reproduced. The regenerative process, then, clearly illustrates to us from another point of view the great importance of the young type of cells.

This completes the evidence which my time permits me to lay before you in order to convince you that really the young type of cells is physiologically and functionally important, that it really does possess the power of growth such as I have attributed to it.

We will pass now to another part of our subject, with which the lecture will close. Age represents the result of a progressive cytomorphosis. We have learned that of cytomorphosis death is the end, the culmination. It is a necessary result of the modification and change of structure which goes on in every individual of our species and of all the higher animals. We are familiar with the death of cells. It occurs constantly and, as I have endeavored to explain to you, it plays a great part in life. It promotes the performance of various functions which are of advantage to the body as a whole, which could not be accomplished without the death of some cells. But the death which we have in mind when we speak ordinarily of death is something different from this. It is the death of the whole. But even the death of the whole has its strange complications. A great deal of our knowledge of the functioning of the body is due to the fact that the parts do not die when, as we commonly say, the body as a whole, the individual, is dead. The organ is alive and well. One

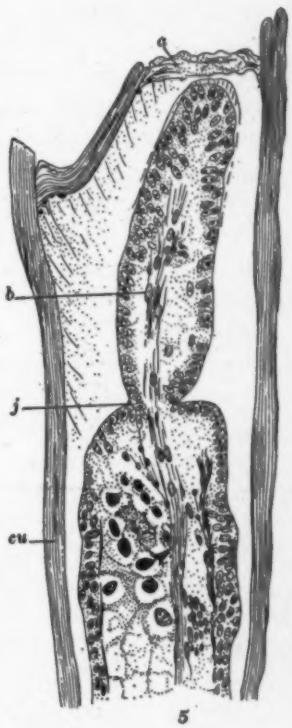


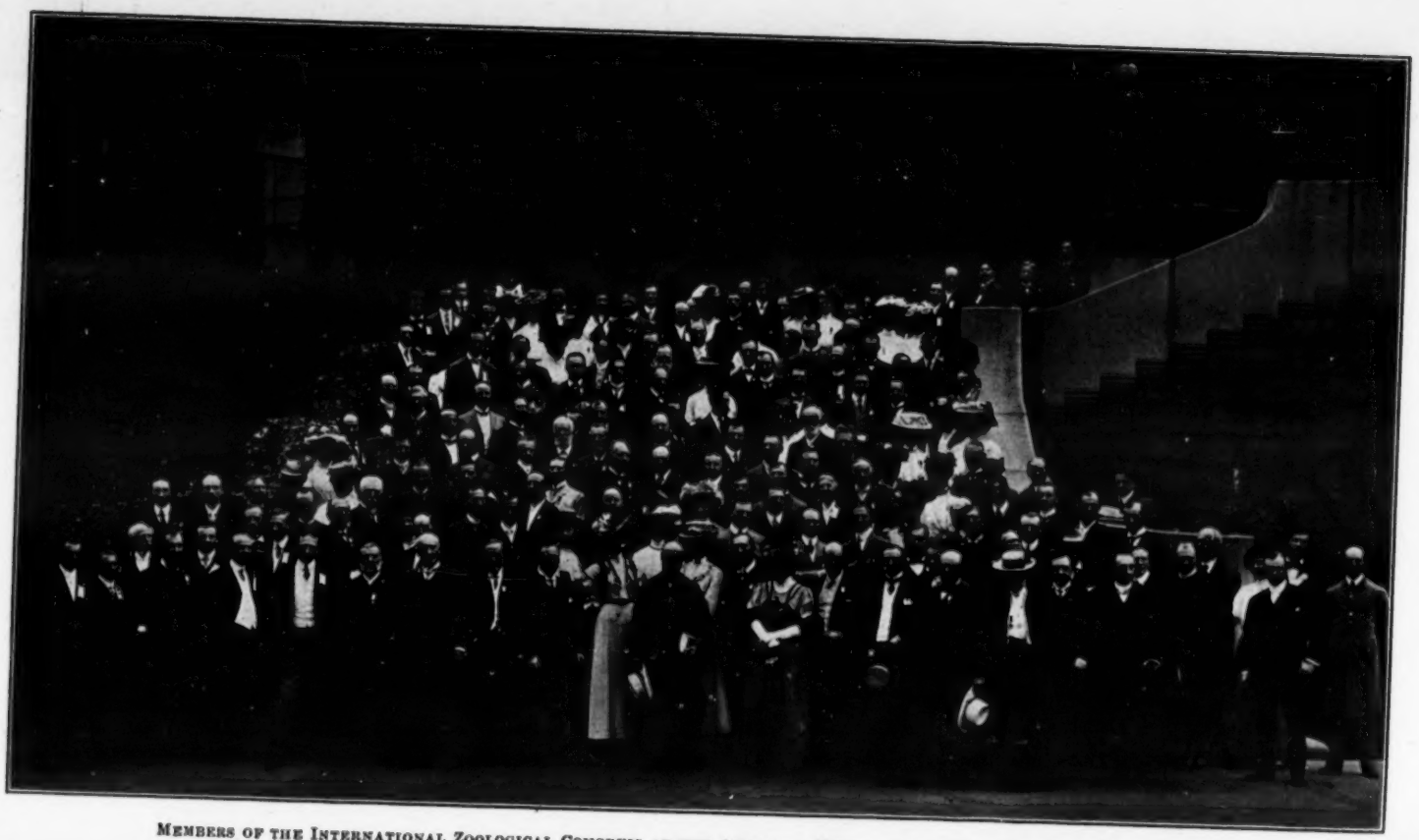
FIG. 60. SECTION THROUGH A REGENERATING ANTENNA OF *Oniscus*. After Ost. Advanced stage, in which the young new joint is already shaped within the old shell. *a*, cicatricial tissue; *b*, regenerated tissue: *j*, new joint; *cu*, cuticula (old shell). Magnified.

of the most impressive sights which I have ever seen has been the sight of the heart of a quadruped, a dog, continuing to beat after it had been taken out from the body. The dog was dead—the rest of his body was dead—but the heart lay upon the physiologist's table beating. The experimenter could supply it with the necessary circulation. He could give stimuli to it, and under these favorable conditions make important discoveries in regard to the functioning of the heart. So too I myself made experiments upon a muscle once part of a living dog, separated entirely from the parent body, supplied with its own artificial circulation, and from those experiments was able to discover some new unexpected results in regard to the nutrition of the muscle, and the changes which chemically go on in it. This over-living, then, of the parts of the body, their separate life, is something which we must familiarize ourselves with, and the great importance of which we must carefully acknowledge, for much of the benefit which the medical practitioner is able to render to us and to our friends to-day is due to the knowledge which has been derived experimentally from the study of the over-living or surviving parts of a body which as a whole was dead.

Death is not a universal accompaniment of life. In the lower organisms death does not occur as a natural and necessary result of life. Death with them is purely the result of an accident, some external cause. Natural death is a thing which has been acquired in the process of evolution. Why should it have been acquired? You will, I think, readily answer this question if you hold that the views which I have been bringing before you have been well defended, by saying that it is due to differentiation, that when the cells acquire the additional faculty of passing beyond the simple stage to the more complicated organization, they lose something of their vitality, something of their power of growth, something of their possibilities of perpetuation; and as the organization in the process of evolution becomes higher and higher, this necessity for change becomes more and more imperative. But it involves the end. Differentiation leads up, as its inevitable conclusion, to death. Death is the price we are obliged to pay for our organization, for the differentiation which exists in us. Is it too high a price? To that organization we are indebted for the great array of faculties with which we are endowed. To it we are indebted for the means of appreciating the sort of world, the kind of universe, in which we are placed. To it we are indebted for all the conveniences of existence, by which we are able to carry on our physiological processes in a far better and more comfortable manner than can the lower forms of life. To it we are indebted for the possibility of those human relations which are among the most precious parts of our experience. And we are indebted to it also for the possibility of the higher spiritual emotions. All this is what we have bought at the

price of death, and it does not seem to me too much for us to pay. We would not, I think, any of us, wish to go back to the condition of the lowly organism which might perpetuate its own kind and suffer death only as a result of accident in order that we might live on this earth perpetually; we would not think of it for a moment. We accept the price. Death of the whole comes, as we now know, whenever some essential part of the body gives way—sometimes one, sometimes another; perhaps the brain, perhaps the heart, perhaps one of the other internal organs may be the first in which the change of cytomorphosis goes so far that it can no longer perform its share of work, and failing, brings about the failure of the whole. This is the scientific view of death. It leaves death with all its mystery, with all its sacredness; we are not in the least able at the present time to say what life is, still less, perhaps, what death is. We say of certain things—they are alive; of certain others—they are dead; but what the difference may be, what is essential to those two states, science is utterly unable to tell us at the present time. It is a phenomenon with which we are so familiar that perhaps we do not think enough about it.

In the next lecture there will be some other general aspects of our subject to present to you, and a formulation of the general conclusions towards which all the lectures have aimed.



MEMBERS OF THE INTERNATIONAL ZOOLOGICAL CONGRESS AT THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY.

THE PROGRESS OF SCIENCE

MORTALITY STATISTICS

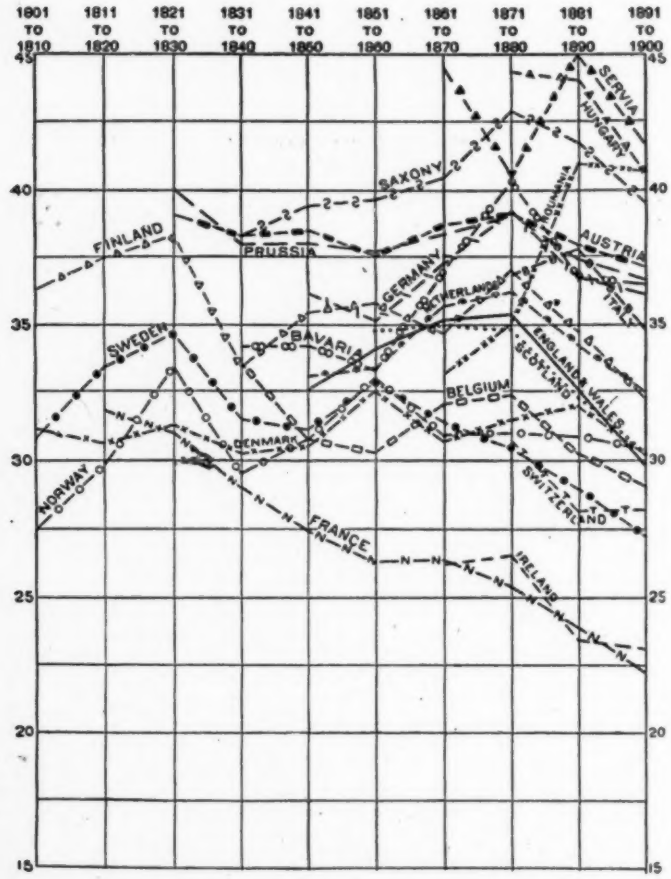
THE Bureau of the Census has just issued its annual report on mortality statistics for the year 1905. There is surely nothing more dramatic than tables of death rates, however uninteresting they may appear to the casual observer. Thus the death rate in Indiana and in Michigan is scarcely above 13 a thousand, whereas in European Russia it is 33. If the population of European Russia is assumed to be 130 million, this means that of the 4,290,000 people who die annually in that country 2,600,000 would not die if the conditions were as favorable as they are in Indiana and Michigan. There is no reason to suppose that the Russians are naturally less vigorous than those living in our central states, and this great loss of life—besides which the number of those killed in the Russian-Japanese war is insignificant—must be due to conditions of life which could be remedied. It is probable that in the cases of the states quoted, and in some parts of Great Britain, Norway and Sweden where the rate is equally low, it is still very much higher than it should be. We may hope that the publication of the death rates may itself have a tendency to call attention to the enormous annual sacrifice of life, and it is consequently fortunate that the Bureau of the Census is now able to publish annually a volume of statistics and that the area covered by the statistics tends to increase.

In 1890 the states in which registration was effective had a population of about twenty million, and in addition there were registration cities having a population of about ten million. In the year 1906 the states of California, Colorado, Maryland, Pennsylvania and South Dakota were added to those which maintain effective registration. The population now included in the registration area is over thirty-six million, or nearly half the total population.

Indiana and Michigan have the lowest death rates among the registration states; the death rates being, respectively, 15.3 and 14.7 in their cities, and 12.7 and 12.8 in their rural districts. In New York City the death rate was 19.4 as the average of the five years from 1900 to 1904. The cities having the lowest death rates were St. Joseph, Mo., St. Paul, Minn., and Minneapolis, Minn., where rates, respectively, of 7.6, 10 and 10.6 are assigned. Charleston, S. C., has the highest death rate—31.3—but here, as in other southern states with abnormally high death rates, the incidence is on the negro population. The death rate at Charleston, for example, is 22.9 for whites and 44.3 for negroes.

Tuberculosis of the lungs is still by far the most fatal of all diseases, causing 172 deaths each year for each hundred thousand of the population. It is followed by pneumonia with 135, heart disease with 121, diarrhœa with 113, and nephritis and Bright's disease with 94. There is a tendency for diseases such as apoplexy and cancer, which affect mainly elderly persons, to increase, and this is of course a gratifying indication that the relative number of those living beyond middle age is increasing. Contagious diseases naturally show large fluctuations, but scarlet fever appears to have decidedly decreased, the number of deaths per thousand having fallen from 12 to 7.

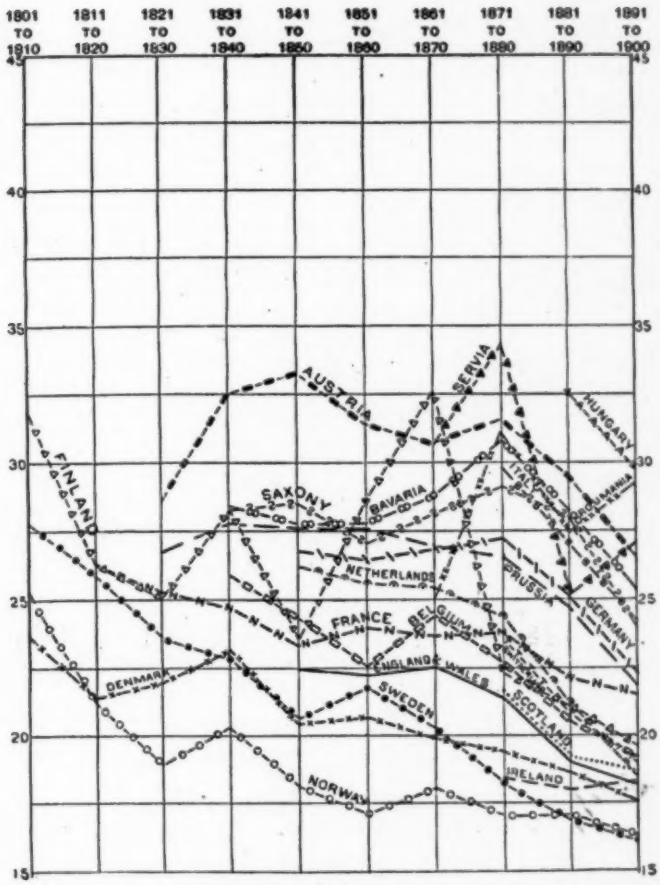
We reproduce diagrams originally



AVERAGE ANNUAL BIRTH RATES OF CERTAIN EUROPEAN COUNTRIES PER 1,000 OF POPULATION, BY DECADES (STILLBIRTHS EXCLUDED).

prepared under the auspices of the French government showing graphically the average annual number of births and deaths per thousand of population in those countries which publish adequate statistics. It will be noted that in all parts of the civilized world both the birth rates and the death rates tend to decrease, and that, as a rule, those countries having the lowest death rates have also the lowest birth rates. As is well known, the lowest birth rate is that of the French—22.2 during the decade 1891 to 1900 and still falling. This is followed very closely by the figures for Ireland—23. There is then a break to Sweden and Switzerland, with birth rates, respectively, of 27.2 and 28.1. The highest birth rates recorded are in Servia and Roumania. Germany has a birth rate of 36.1; England and Wales of 29.9. During the last twenty years the birth rate has fallen in every country and the death rate has also fallen in practically all countries. The lowest death rates, 16.1 and 16.3, respectively, are in Sweden and Norway. The highest, 33.4 and 30, respectively, are in Russia and Spain.

It should be remembered that the birth rate and the death rate have



AVERAGE ANNUAL DEATH RATES OF CERTAIN EUROPEAN COUNTRIES PER 1,000 OF POPULATION, BY DECADES (STILLBIRTHS EXCLUDED).

probably decreased even more rapidly than the statistics show, as births and deaths, as a rule, tend to be more accurately recorded now than formerly. Thus it is by no means certain that the birth rate in England increased from the period 1841–50 to 1871–80. Even now when an infant dies at an early age, the registration of both birth and death is sometimes not recorded, and this custom was doubtless formerly more prevalent than it is at present.

THE GROWTH OF THE STATE UNIVERSITIES

THE first bulletin of the Carnegie Foundation, which is concerned with the admission of the officers of state universities to retiring allowances, contains a good deal of interesting information in regard to the growth of these institutions, part of which is summarized in the accompanying table. The first column gives the date of founding, and some may be surprised to find that the first state universities were established in the south, Michigan, often looked upon as the oldest state university, being in fact the tenth in order. Another circumstance perhaps not generally known is the fact that two state universities were established in Ohio at the early dates of 1804 and 1824, and that the Ohio State

University	Date of Founding	No. in Faculty	No. in Instructing Staff	Student Registration		Annual Tuition.		Annual Receipts.		Approximate Total Gifts from State and Gen'l Gov't Since Founding	Approximate Total Gifts from Private Citizens Since Founding	Academic Standard in Units
				College Students	Total Enrollment	For Residents of State	For Non-residents of State	1896	1906			
Georgia..	1785	23	35	157	408	None	50.00	27,614	82,642	240,000	142,500	11
North Carolina	1789	36	74	462	870	30.00	30.00	25,000	235,603	705,000	705,273	11.6
Tennessee	1794	27	105	283	695	86.00	86.00	61,410	88,390	1,877,250	43,896	10
South Carolina	1801	19	28	151	296	58 00	58.00	25,000	41,730	2,556,000	None	5.2
Ohio (Athens)	1804	22	49	389	1272	15.00	15.00	27,670	135,198	600,000	31,000	12
Indiana	1820	49	109	.....	1684	None	None	114,584	252,138	2,500,000	100,000	15
Miami	1824	36	43	261	991	15.00	15.00	18,341	97,472	1,038,400	50,000	14
Virginia	1825	35	80	.....	706	40.00	115.00	70,861	111,094	1,710,000	1,627,195	8.4
Alabama	1831	17	43	249	491	27.00	87.00	29,625	56,053	No record		10
Michigan	1837	113	332	3772	4136	30 00	40.00	227,707	451,697	6,407,003	817,851	14
Missouri	1840	85	179	1541	2072	5.00	5.00	127,709	366,111	3,211,797	294,000	15
Iowa ..	1847	53	150	1341	1815	20.00	20.00	101,554	432,304	3,525,666	52,750	15
Mississippi	1848	17	27	303	571	2.50	2.50	32,643	144,704	2,124,000	40,000	11
Wisconsin	1848	119	317	2443	3571	20.00	50.00	314,436	804,521	6,603,860	90,941	14
Utah ..	1850	30	92	203	1063	10.00	10.00	55,152	159,007	1,691,000	65,000	10.7
Louisiana	1860	27	38	311	458	None	60.00	36,525	65,214	1,252,245	43,308	9.5
Washington..	1861	43	79	709	925	None	20.00	70,000	149,345	2,892,840	500,000	15
Kansas ..	1864	88	104	1348	1706	10.00	20.00	104,715	391,778	3,171,812	400,000	15
Maine	1867	28	64	540	687	60.00	70 00	29,900	41,900	581,718	155,000	13.5
West Virginia..	1867	36	66	299	1422	12.00	62.00	27,248	138.660	1,159,221	75,000	12.5
California	1868	116	403	3897	4173	None	20.00	325,495	727,536	Data not available		15
Illinois	1868	156	408	2792	4074	24.00	24.00	144,455	825,107	6,443,752	25,000	14
Minnesota..	1868	90	347	2929	3955	20.00	40.00	199,221	345,261	5,359,208	191,000	15
Nebraska ..	1869	84	190	2122	2914	6.00	26.00	70,655	357,060	3,805,149	70,717	14
Ohio State (Columbus) ...	1870	92	151	.....	2157	18.00	18.00	112,784	628,000	4,881,063	281,285	14
Arkansas	1872	36	64	381	1528	None	None	120,400	143,900	1,760,000	None	10
Oregon ..	1876	19	79	369	506	15.00	15.00	37,200	117,200	890,824	50,000	15
Colorado	1877	131	115	700	1327	10.00	10.00	86,500	140,000	1,727,125	55,000	15
South Dakota	1882	24	44	180	381	5.50	5.50	20,000	68,750	No record		15
North Dakota	1883	18	50	189	733	8.00	8.00	12,500	177,250	1,000,000	70,000	13
Texas	1883	43	119	1385	1991	10.00	10.00	123,413	289,193	3,792,307	150,000	11.4
Nevada	1886	23	27	143	254	None	None	37,250	130,000	429,839	85,000	12
Wyoming	1886	18	26	118	241	2.50	2.50	2,933	26,081	510,844	1,100	14
Idaho	1889	16	45	231	363	None	?	45,616	96,537	567,215	75,000	15
Arizona	1891	13	24	47	226	None	20.00	10,500	32,200	245,000	10,000	15
New Mexico	1891	8	19	28	89	6.00	40.00	11,500	29,615	272,021	14,182	15
Oklahoma	1892	19	29	203	475	None	None	Rec. des. by fire	85,000	.....	.....	15
Montana	1895	15	23	142	289	10.00	10.00	22,000	57,000	368,710	None	14
Florida	1904	14	14	70	136	10.00	30.00	.....	57,710	170,000	40,000	9.9

University at Columbus was not established until 1870. The University of Florida, established in 1904, makes the number of state universities thirty-nine, and, as there are three in Ohio, the number of states and territories having state universities is thirty-seven.

Nearly all the universities of the eastern states have at one time or another received appropriations from the state and have been to a certain extent under state control, and at present certain universities, such as Pennsylvania and Cornell, may be regarded as partly state institutions. In each case the governor of the state is a member of the board of trustees and appropriations are made by the state for the support of the university.

The next column of the table gives the numbers of instructors and students, according to which the University of New Mexico, with 89 students and nineteen instructors, is the smallest of the institutions, while the largest are Wisconsin, with 3,571 students and 317 instructors; Minnesota, with 3,955 students and 317 instructors; Illinois, with 4,074 students and 408 instructors; Michigan, with 4,136 students and 332 instructors, and California, with 4,173 students and 403 instructors. According to the figures annually compiled by Professor Tombo and published in *Science*, the five largest universities which are independent of the state are Harvard, with 5,343 students and 583 instructors; Chicago, with 4,731 students and 341 instructors; Columbia, with 4,650 students and 600 instructors; Cornell, with 4,075 students and 525 instructors; and Pennsylvania, with 3,934 students and 375 instructors. It will thus be seen that the leading corporations do not differ greatly in size.

The table next gives the annual tuition fees, whence it appears that Indiana, Arkansas, Nevada and Oklahoma charge no fees, while in a number of other states the fees are nominal. Several of the universities charge higher fees to non-residents than to residents of the state. Perhaps the most interesting data on the table are the comparisons of the annual income apart from tuition fees of these universities in 1896 and 1906. There is here an increase that holds for every institution without exception and which is certainly most remarkable. Thus the annual income of the ten principle universities of the middle west was in 1896 $1,689,200, whereas ten years later it was $4,577,700. The figures given in the table are, however, somewhat obscured by the fact that there is no distinction made between appropriations for current income and for new buildings. The two following columns give the approximate total appropriations from the state and gifts from private sources, showing clearly how largely state universities are dependent on the public for support. Thus Illinois, which has received $6,000,000 from the state, has only received $25,000 by private gift. Some of the universities, as Michigan and California, have, however, received considerable gifts. In his report President Pritchett urges that the universities must depend either on public appropriations or on private gifts, and this point of view is on the whole supported by these figures and by conditions in foreign countries. The conditions, however, are not necessarily final. In New York City, for example, there are admirable museums of natural history and of the fine arts and botanical and zoological gardens which are supported almost equally by the city and by private gifts.

SCIENTIFIC ITEMS

We regret to record the deaths of Major James Carroll, U. S. A., known for his researches on yellow fever, and of Professor W. O. Atwater, of Wesleyan University, known for his researches on nutrition.

AN institution for the suppression of tuberculosis is planned in Germany in honor of the twenty-fifth anniversary of the discovery of tuberculosis by Professor Robert Koch. Appeal is made for contributions sufficient to make the institution a tribute of gratitude to Koch, similar to those with which the name of Pasteur has been honored in France and that of Lister in England.—A "Morley Chemical Laboratory," named in honor of Dr. Edward W. Morley, emeritus professor of chemistry, will be built at Western Reserve University during the present year.

PROFESSOR A. N. SKINNER, of the U. S. Naval Observatory, has retired on reaching the age limit of 62 years. —Dr. Ellwood Mead, chief of irrigation investigation of the U. S. Department of Agriculture and professor of irrigation in the University of California, has accepted the office of chief of irrigation investigations for Australia.